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The Westinghouse Four-Pole Motor. WE take pleasure in fully illustrating in another column the slow-speed Westinghouse motor in its finished form. Last week we gave some brief account of the experimental stages of the machine, and what was then said is more emphatically true of the completed type. The very slow speed of the armature, the completeness with which both motor and gears are cased in, and the strength and simplicity of the mechanical construction are all points that will be appreciated by practical railway men. The characteristic feature of the Westinghouse railway motors, the hinged arrangement of the magnetic circuit, so that part of it can be swung back for access to the field coils and armature, is one of the most admirable features of the present, as well as the original, form of machine.

The Phonopore. WE present this week a description of a new telegraph system that has been attracting some attention in London during the past year. It is called by its inventor the phonopore, and is in reality an ingeniously modified harmonic telegraph, arranged to operate indirectly an ordinary Morse sounder. The principle involved is the use of a vibrating reed as a relay, set into motion by vibratory impulses sent through an ordinary telegraph line by induction. As will be seen from the more detailed description, it enables an ordinary line to be duplexed with great facility, and with the additional advantage that the phonopore system is quite independent of the ordinary signals, and, consequently, two messages can be sent in the same direction as well as in opposite directions. It is a very ingenious device, and in its experimental use has met with such success as to promise well for its commercial future if it can once be fairly introduced to the public.

Insulation for Dynamos. A BRIEF communication from Mr. H. Franklin Watts, in another column, contains a suggestion that, we must confess, strikes us as exceedingly pertinent. It must indeed seem foolhardy to one unacquainted with electricity to make the integrity of a machine depend on what seems at first sight so inadequate a protection as a thin covering of cotton and shellac. Fortunately, we can confine the electric current by such means with quite uniform success, but now and then occasion arises when an insulation having better mechanical properties is an absolute necessity. Especially is this the case in motors, subject as they are to strains infinitely more severe than fall to the lot of the dynamo. The ideal motor is one in which the armature conductors are, from a mechanical standpoint, virtually a part of the core; in other words, where they are so firmly united to the core that they run no risk from anything short of a direct blow. Once given conductors thus firmly fixed in place, the problem of insulating them becomes very much easier. Looked at from a mechanical standpoint, a smooth armature, wound with several layers of thinly insulated round wire, secured by being tied to the core by binding wires, is not an admirable contrivance. It is difficult to arrange for solid and substantial insulation. If such were not the case we would have had it long before this. Nevertheless, it is an end which should be, and eventually will be, attained. The necessity for it will become doubly apparent when large railway motors are put into service under severe strains. Street railway practice has told its tale of faulty insulation only too plainly, and it is high time that proper attention was paid to developing this particular branch of electrical mechanics.

Resistance Measurements. AN exceedingly practical and serviceable paper is that on "The Commercial Measurement of High Resistances," by Carl Hering, published elsewhere in our columns. In these modern days of high voltages, when the severest kind of service is exacted from insulated wires, the determination of insulation resistance becomes a matter of prime importance. While not a difficult task, it is one that requires peculiar precautions. The Wheatstone bridge universally employed for ordinary resistance determinations is not conveniently applicable to the measurement of the enormously high resistances found in the insulation of the best modern wires. For such work the bridge is practically abandoned, and the method employed is in general that of the comparison of the deflections produced on a very sensitive galvanometer through a known resistance and through the resistance to be tested. The other measurements frequently required in commercial work are for static capacity, locating faults in a long reel of cable, and, finally, measuring the conductivity of the copper itself. This last is usually done by the ordinary bridge method. Beside the necessary exactness of the experiments, additional difficulties are met in the insulation of the apparatus and batteries, and the elimination of static capacity, as far as is possible. Mr. Hering's paper gives in detail the connections, arrangement and methods of work employed in commercial testing of high resistance wires. The system described is in actual use in a large factory with great success, so that all the arrangements described are thoroughly practical. The diagram of the connections is so explicit that our readers will find no difficulty in comprehending and putting into practice Mr. Hering's very neat system. There is nothing radically new in the apparatus, or in the method of employing it, but it is combined and arranged in such a way as to give the best results with a minimum of trouble, while all the necessary precautions are explained with a fullness that leaves little to be desired.

Cable or Electricity? WE are glad to know that no active steps have as yet been taken toward the threatened cable railway system on the Broadway and Third Avenue lines in this city. Considering the experience of Minneapolis, where several hundred thousand dollars' worth of cable apparatus was thrown into the scrap heap, to be replaced by motors, the action of the companies concerned in thus delaying any changes in their motive power is certainly wise. Even if it should prove impossible to introduce the trolley system in this city, we shall probably not be cut off from the use of electricity. There are rumors in the air of more than one substitute for the much-abused overhead wire. Several new storage battery systems are in course of experimental trial, and have given promise of some practical results. And, beside these, there are suggestions of still other plans for furnishing electric power. For our part, we firmly believe that the objections that have been raised to the trolley wire in other cities are entirely without proper foundation, and it would not seem at all a public calamity if the method of electrical traction that has proved itself thoroughly successful in Boston should be given a trial here. There is certainly a chance for its immediate use in the annexed district, and it is not altogether impossible that a brief experience with it there might go far to do away with the altogether unreasonable objections that have been raised against it. If it should be thought best to wait for some more æsthetic method of electrical supply, we are convinced that the period of uncertainty will not last for any great length of time. The horse car service on both Broadway and Third avenue is tolerably satisfactory, and we are pleased that there is no immediate prospect of our streets being converted into sewers by running through them the unwieldy cable conduits, necessitating the displacement of the elaborate existing systems of pipes and causing not only public inconvenience, but enormous expense to the companies concerned. Give electricity the chance and it will do the work to the satisfaction of both the stockholders and the traveling public.

Transformer Efficiency Again. WE take pleasure in printing in this issue a brief statement from Mr. E. W. Rice, Jr., concerning the commercial efficiency of the Thomson-Houston type of transformer, as tested at the factory. Mr. Rice's remarks were called forth by the tests at the Stanley laboratory, published in our issue of Jan. 21. The results reached in the tests at Lynn went to show an efficiency for the 25-light size of transformer five per cent. greater than that obtained by Mr. Stanley. We have every reason to believe, both from the high character of the experimenters and internal evidence in the tests, that both the results reached are thoroughly credible. Comparing them, we find that the losses due to resistance, and the fall of potential in the secondary given by Mr. Stanley are slightly smaller than the same quantities determined at the Thomson-Houston factory. The difference in efficiency, therefore, seems to be wholly due to the difference in losses by hysteresis, and this is what might reasonably be expected. In small transformers having a comparatively large amount of iron the hysteresis losses are relatively large, and they are well known to be somewhat erratic in character. A difference in annealing may fully double the hysteresis loss in a transformer, and two kinds of iron of nominally the same character may often differ very widely. Hence the natural conclusion to be reached from these two divergent tests, both on recent specimens of the same type of transformer, is that either the transformer tested by Mr. Stanley was constructed of iron in which the hysteresis was unusually heavy, or that the specimen tested at the factory happened to be of exceptionally fine iron. The losses from hysteresis are, as we have already noted, so easily varied that such a contingency is quite probable. We are glad to hear that the whole series of transformers mentioned by Mr. Rice is to be given a thorough test at the Massachusetts Institute of Technology, but we shall not regard the results as any more valuable than those already furnished by Mr. Rice, inasmuch as while the experimental work in both cases is presumably conscientious and accurate, the transformer in neither case would be procured in the open market. Tests of commercial transformers are much needed, and will furnish very instructive results, but the specimens tested should, for fairness to all parties concerned, be taken out of stock without any suggestion of the possibility of a test.

Rapid Transit for New York. THE rapid transit symposium at the Electric Club on Feb. 26 was most interesting, both from the elaborate nature of the discussion indulged in and from the great evidence of present activity displayed. Mr. F. J. Sprague's paper was listened to with the keenest interest as coming from one having long experience as an expert in electrical traction. The general consensus of opinion of all the assembled engineers seemed to be that the ultimate solution of the rapid transit question in this city must be found in an underground system. The public will not tolerate four-track elevated roads through its streets, and a viaduct, admirable as it would be, is practically prohibited by the enormous cost of construction and right of way. It is necessary for any system of rapid transit that can adequately supply the pressing needs now felt to run, not through unfrequented and comparatively unused portions of the city, but right through the heart of the business district. Routes might be found over which a viaduct could be run without prohibitive cost, but these routes are not those that will fulfill the condition above named. Hence it is that, in spite of the undoubted advantages of the viaduct system, we must turn away from it and adopt the underground construction as the only available expedient. The plan proposed by Mr. Sprague at the meeting in question, and reported elsewhere in our columns, is a very radical one and involves the construction of 125 miles of single track tunnel; but at the same time it is a most comprehensive scheme, and would undoubtedly be a complete solution of the problem for many years to come. Nevertheless, it is doubtful if capital would be ready to undertake at once the enormous outlay required, and, all unwillingly, we may be compelled to adopt an underground system on a more modest scale. Following Mr. Sprague, Mr. Sterne, the engineer of the Greathead system that has scored a most brilliant success in London, gave a most interesting account of the work in that city; and the impression was strong on the minds of the auditors that whatever might be said of other tunnel systems, the Greathead construction is a demonstrated success, and can be employed in this city with facility, and at a comparatively moderate cost. At all events, whatever engineering plans may finally be adopted, the electric motor is the only thing available for motive power in any practicable variety of tunnel. Fortunately the experience of the City and South London Railway has set at rest any doubts that might linger in the minds of the sceptical as to the practicability of using the electric motor for rapid transit on a large scale; and with the results of that successful road for instruction, it ought to be a comparatively simple task to equip any underground system that may be decided upon in a thoroughly successful manner.

Latest Foreign Electrical News.

(By Cable from our Regular Correspondent.)

London, March 2, 1891.—The discussion of Mr. Swinburne's paper on "Transformer Distribution" before the Institution of Electrical Engineers proved to be of the greatest interest. The principal speakers were Messrs. Esson, Mordey, Crompton, Evershead and Addenbroke, and many valuable points were raised in connection with the paper that had just been read. Mr. Swinburne's advocacy of transformer sub-stations of considerable capacity feeding low-pressure mains was generally supported, although there was much difference of opinion as to the value of his theory of armature reactions in alternating current dynamos. The superior all-day efficiency claimed for Mr. Swinburne's hedgehog transformer was, however, vigorously assaulted, as might have been expected.

The Barnesley Town Council has been much hampered in its efforts to introduce electric lighting by adverse action on the part of the Board of Trade and by the Westinghouse Company throwing up the contract on financial grounds.

NEW BOOKS.

First Principles of Electrical Engineering, by C. H. W. Biggs. Pp. 190; ills., 129. Biggs & Co., London. 1890.

It is a very difficult matter to write an elementary book on a great subject. It is, perhaps, peculiarly so when that subject is one that combines the simple and the abstruse so intimately as does electrical engineering. In writing on this topic one must be continually confronted by the fact that a very large number into whose hands the book will necessarily fall know very little of electrical theory, or even of the simplest mathematical nomenclature, without which it is difficult to express mathematical facts. The present treatise is a careful and commendable effort to put before the non-technical reader the rudiments of that great branch of applied science that is to-day so prominent. It is intended to be exceedingly simple in treatment, and so in the main it is, although it requires rather careful reading from those not already somewhat familiar with electrical ideas. The author takes up at first electrical conduction, and explains the nature of resistance in series and in parallel, and some of the applications of Ohm's law, in a very simple manner, illustrating the facts by plain examples. His treatment of the inductive circuit, introduced at this point, is clear, but might better have been postponed to a later part of the book. The magnetic circuit receives a similar simple treatment, and then the methods of producing electrical pressure are taken up successively: the static machine, the battery and, finally, the dynamo, to which a simple account of graphical construction serves as a prelude. The account of dynamos, their construction and properties, is very simple, and follows the ordinary line of treatment quite closely. A brief chapter on electrical distribution and on simple electrical measurements closes the volume. The facts given are, for the most part, correct, although we must take sharp exception to the statement that it is impossible to attribute too much importance to the fact that no electric or magnetic phenomena occur in bodies that are outside the circuits. If our definition of circuit be made sufficiently broad, this statement would be true, but it is admirably fitted to mislead. Altogether there is much in this little book that may be read with advantage by the non-technical student of applied electricity. It is sometimes condensed too much to be easy reading for one who has no previous knowledge of the subject; but, at least, it contains fewer mistakes and more useful facts than most similar attempts at imparting elementary knowledge of things electrical.

A Storage Car System in Washington.

The Eckington & Soldiers' Home Railway Company, in the District of Columbia, was one of the first in the United States to adopt electricity as a means of propelling its cars. Congress, however, will not permit the railway company to erect any more trolley poles, particularly in the heart of the city. It became necessary for the Eckington company to look around for another system for its extension or branch from New York avenue and Fifth streets via the Pension Office and G street, to Fifteenth street, opposite the Treasury Department, including a proposed extension to the Capitol. Col. George Truesdale, the president of the railway company, has finally decided upon the Edco system as one fully meeting all the requirements. The cars for the Eckington & Soldiers' Home road are being manufactured by the J. G. Brill Company of Philadelphia, and will be upholstered and finished in handsome style, lighted by electricity, equipped with the Edco motors and gearing, and with a sufficient number of "23M" type accumulators, made by the Accumulator Company, to run an average speed of eight miles an hour and a maximum speed, when desired, of 15 miles an hour. The Brill Company will deliver the cars about the last of March, and they will be equipped and installed in running order within about 60 days thereafter.

ELECTRICAL WORLD PORTRAITS.—XXII.

CARL HERING, B. S., M. E.

Few electricians are better known in this country and abroad than the subject of this sketch, who was born in Philadelphia, Pa., in 1860 and is one of the five sons of the late Dr. Constantine Hering, one of the founders of homeopathy in America. He is of German descent; his parents were both born in Germany but lived in America the greater part of their lives. He received his collegiate education in the University of Pennsylvania at Philadelphia, entering in 1876. As physics and mechanical engineering were his favorite branches, he took the course in mechanical engineering under Prof. Wm. D. Marks, and was graduated with honors in 1880, taking both the degree of Bachelor of Sciences and that of Mechanical Engineering.

In 1881 he was appointed instructor in mathematics and assistant in mechanical engineering in the University of Pennsylvania, which position he relinquished a year later to become assistant in physics in the same university under Professor Barker, at that time one of the principal consulting electricians of the Edison Company. His object in taking this position was to take up the study of electrical engineering, just then beginning to become an important branch in engineering, but not yet taught anywhere as a special course. While there he published his first article, a table of equivalents of electrical and mechanical units of measurements. A year later he decided to go abroad and study the subject there. He was at that time (1883) elected Commissioner of the Franklin Institute of Pennsylvania to the International Electrical Exhibition at Vienna, at which exhibition he was made an active member (the only one from the United States) of the international jury or scientific commission that undertook the elaborate scientific tests of the exhibits. This work, which was started on very elaborate plans, continued several months after the closing of the exhibition. From there he went to Darmstadt in Germany to continue his studies in electrical engineering at the Polytechnikum, under Professor Kittler, who had been one of the principal experts at the Vienna exhibition tests. This college was at that time one of the few institutions where electrical engineering was taught as a special course. Shortly after beginning his studies there, Professor Kittler appointed him his assistant, which gave him additional facilities for study and research. In 1884 he returned to this country to become acting electrician for the International Electrical Exhibition in Philadelphia, held under the auspices of the Franklin Institute. He was also made one of the active members of the scientific commission appointed to make the tests and reports of the exhibits. In the latter capacity he urged the importance of a comparative life test of incandescent lamps, which had been wanting in the Munich and Vienna experiments to make them of value. Though this test was at first opposed and ridiculed by many of the prominent members of the commission, it was finally started by Mr. Hering, through the efforts and aid of Professor Marks, who appreciated the importance and value of such a test and who did not fear the work involved. Owing to the elaborate preliminaries and the repeated delays, the tests were not started until after Mr. Hering's departure abroad on business; but they were subsequently carried out on much more elaborate plans through the untiring efforts of Professor Marks, assisted by others. These tests, now well known as the Franklin Institute duration tests, remain the only ones of the kind that were made at an exhibition. Among the testing instruments prepared by Mr. Hering at this exhibition was a galvanometer for measuring volts with an accuracy of one-tenth of one per cent. and a range of from 1 to 3,000 volts; also a calorimetric means of measuring a current of 3,000 amperes, from the Forbes unipolar machine. In the fall of 1884 he returned to Germany, to serve as electrical engineer for one of the large firms there. Later he returned to Philadelphia as consulting electrical engineer for a large company, after which he started a practice as consulting electrical engineer in that city, and is still engaged in that work.

CARL HERING.

In 1886 and 1887 he took charge, temporarily, of the course in electrical engineering at the University of Pennsylvania. In 1889 he was sent to Paris by the United States Government to make the report on the electrical exhibits at the Paris International Exposition. Here he was made one of the two United States members of the international jury to award prizes in class 62 (electricity), his very able colleague being Mr. Abdank-Abakanowicz. He was also elected delegate from the Franklin Institute to this exhibition for the class "electricity," and was representative of the American Institute of Electrical Engineers at the International Electrical Congress in Paris. At the close of the exhibition he received the decoration "Officier de l'Instruction Publique," known as the "Gold Palms," from the French Government. In the spring of 1890 he was elected by the members of the American Institute of Electrical Engineers as the representative they were asked to appoint to act as one of the committee of three judges to award the prizes at the St. Louis Electrical Exhibition of 1890. He is at present devoting himself specially to electrical testing and general expert work. Mr. Hering is the author of a number of papers and tables on electrical subjects, and of two books on dynamos, and is the inventor of several improvements in dynamos and storage batteries.

The First Electric Railway.

BY L. F. ANDREWS.

In the issue of The Electrical World of January 31 I find the report of a paper read before the Electric Club, of New York, by Franklin L. Pope, in which he refers to the probable first electric motor as being the invention of Thomas Davenport, at Brandon, Vt., in 1835-8. He says that with the aid of another mechanic he made a motor. I desire to confirm Mr. Pope's statement. The "other mechanic" was Collins Andrews, my father. I well remember the long and vexatious series of experiments made by these two men. The greatest obstacle they had to contend with was the stopping and starting of the motor. It would run when once started by other power, but to get it to start itself was the vexatious point. They finally succeeded, however, and laid a circular track in the shop. On the car was placed a platform or seat to carry one person, and on this I frequently had the pleasure of making the circuit. At that time, at Brandon, was constructed the first electric motor in the United States.

The Telephone Exchange at Hartford, Conn.

The Hartford building of the Southern New England Telephone Company, the corporation which controls the operation of the American Bell Telephone Company's instruments in the State of Connecticut, illustrated on the opposite page, is one of the most modern buildings planned for telephone purposes. It is situated on the southeast corner of Pearl and South Ann streets, on a lot 50 feet on Pearl street and running back about 112 feet on South Ann street. The building occupies the entire Pearl street front and some 78 feet of the depth of the lot. It is built of brick with granite and brown stone trimmings, and is most substantial in its construction. It is constructed on the slow-burning system. On the ground floor are two stores, running the entire depth of the building, which are entirely separated from the other parts of the building by brick walls. The second story floor is of plank, covered with an inch of fire-proofing material, and on top of that the flooring proper. It is on this story that the business of the company is carried on. The business office is on the front. On one side of the office are built two cabinets, inclosed by plate glass, and made sound-proof, in which are long-distance telephones and all the conveniences for conversation with any of the cities that are connected with the long-distance lines.

Across the entire rear of the second floor runs the operating room. It is well lighted from the south by eight windows and from the west by one window, and is large enough to accommodate a switchboard for 3,000 subscribers. Adjoining the operating room is a parlor and

toilet rooms for the young women who are employed in the room, well lighted and comfortable. Between the operating room and the hall is the distributing room. This is the room into which all the wires of the system come before passing to the switchboard. The room is as nearly fire-proof as the character of the building will permit. The walls are brick and terra-cotta, the ceiling is metal lined, and the floor is asphaltum. One of the features of the room is this floor. It is waterproof, as well as fire-proof, and is so arranged that it can at any time, in case of a sudden fire among the wires, be flooded with water without injury to the remainder of the building. On the outer side of the room stands the distributing board. This is a new design, the work of Mr. George K. Milliken, the electrical mechanic of the company, and Mr. E. B. Baker, the general superintendent. It is of Russia iron, with room for 1,000 pairs of wires. It is in the form of a series of upright channels of sheet iron, bolted and riveted together, on one side of which the wires enter from the cable heads, that are just above it, and from the other side of which the wires run to the switchboard cables.

The switchboard is of the latest pattern, like that now in use in the company's building at New Haven, arranged for metallic circuits. It has an ultimate capacity for more subscribers than the exchange will probably have in twenty years. Its cost is $5,000.

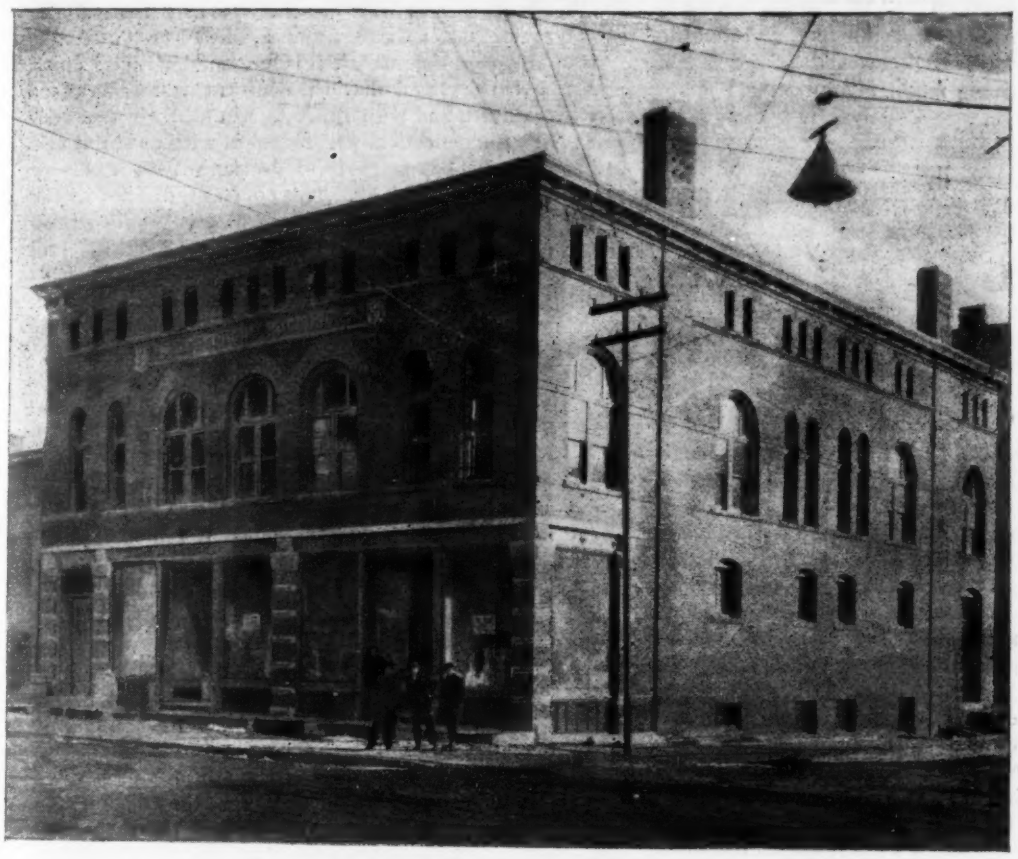
The feature of the building that the company takes the most satisfaction in is the manner in which the wires are brought into it. The roof of the new building does not have a wire upon it. Everything is brought in from the underground ducts. On the east side of the building is a stone stairway, inclosed in heavy brick walls. Under this stairway is a brick and cement walled passage, leading from the manhole in Pearl street up to the floor of the operating story. Here the passage becomes a tight brick shaft, to the attic floor, and is there ended in a heavy flagging. It is through this passage that the cables of the company are brought to the terminal board. At some distance back of the stone stairs, which form the principal entrance to the operating department, is a staircase of iron, running from the second story and opening into the terminal room, down to the floor of the fire-proof passage, on a level with the cellar floor. The cables are hung on the walls of this fire-proof passage, and by means of this iron staircase are within reach of the hand for the entire distance from the terminal room to the manhole in the street. This is considered of the highest importance to the safety of the exchange.

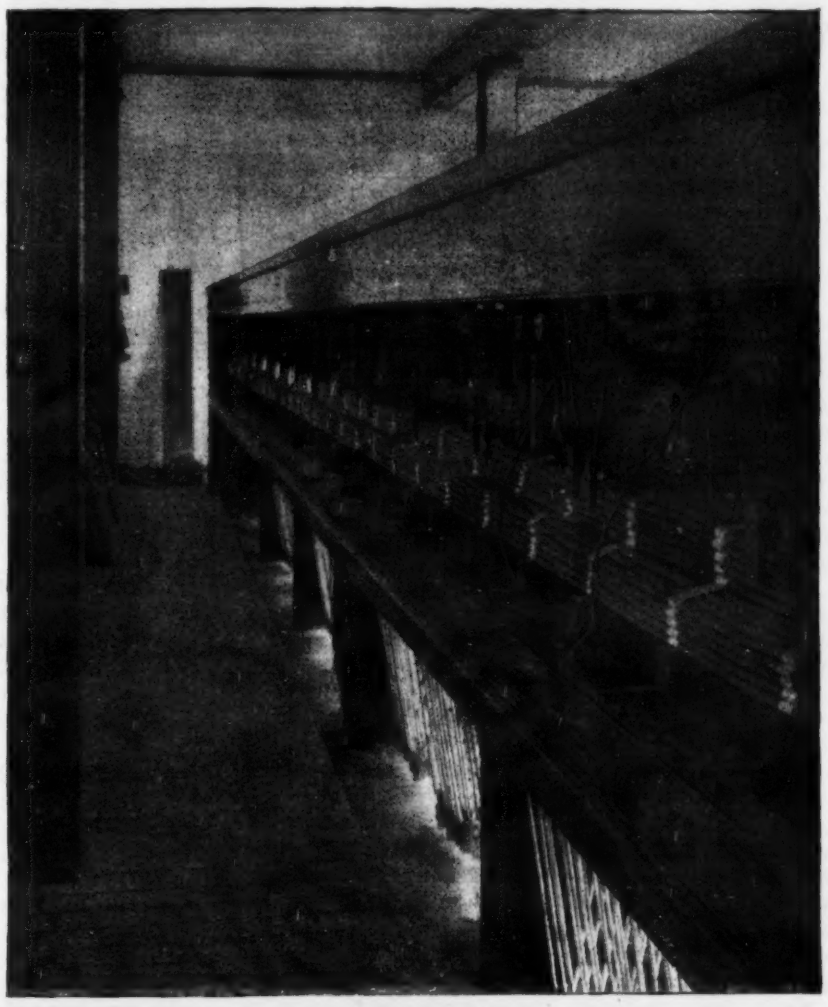
This building as now occupied cost the company, with its equipment, over $40,000. Mr. W. H. Babcock is the company's Hartford manager. The architect of the building was Mr. L. W. Robinson, of New Haven, and the contractors were Messrs. Whiton, Porteus & Co., of Hartford. To Mr. E. B. Baker, the company's general superintendent, credit is due for very many of the most successful features of the building.

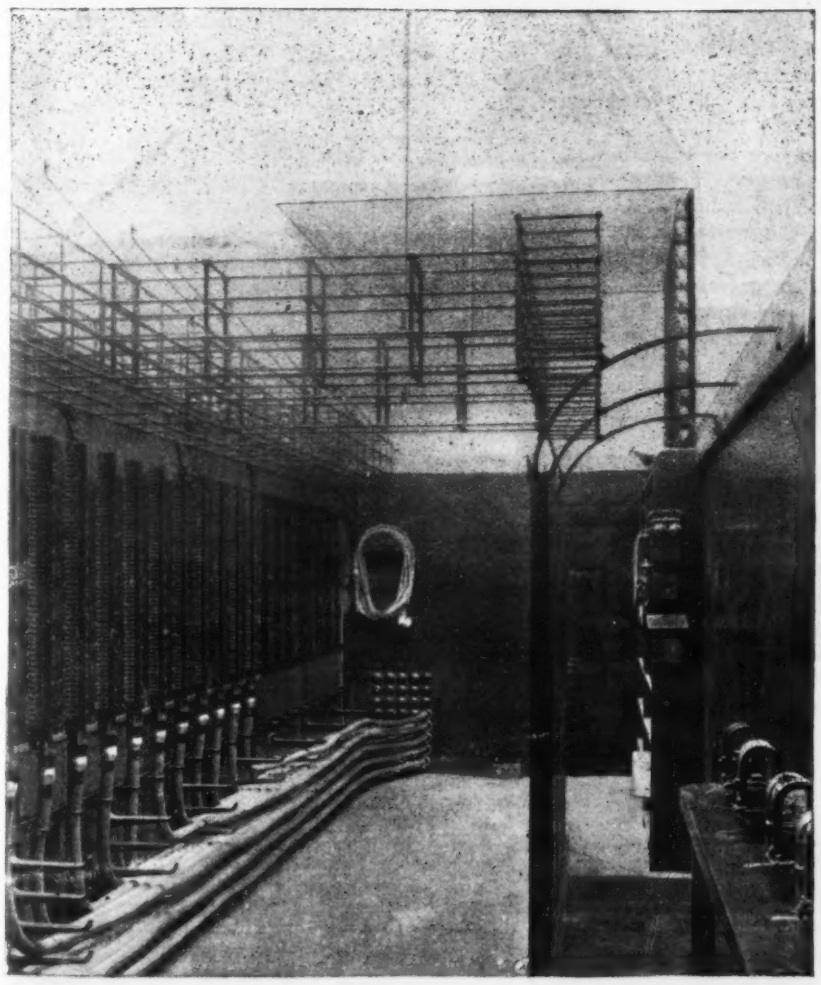
But this central station is not by any means all that the telephone company has recently made in Hartford. It has commenced an entire revolution of its system of construction and of operation. Hitherto the business has been done on what is known as the grounded system. This system has been abandoned in Hartford, and all the work is being done on the metallic circuit plan. This doubling the number of wires in the exchange meant an entire rebuilding, and the introduction of some method of carrying a large number of wires in a compact and unobjectionable manner through the streets.

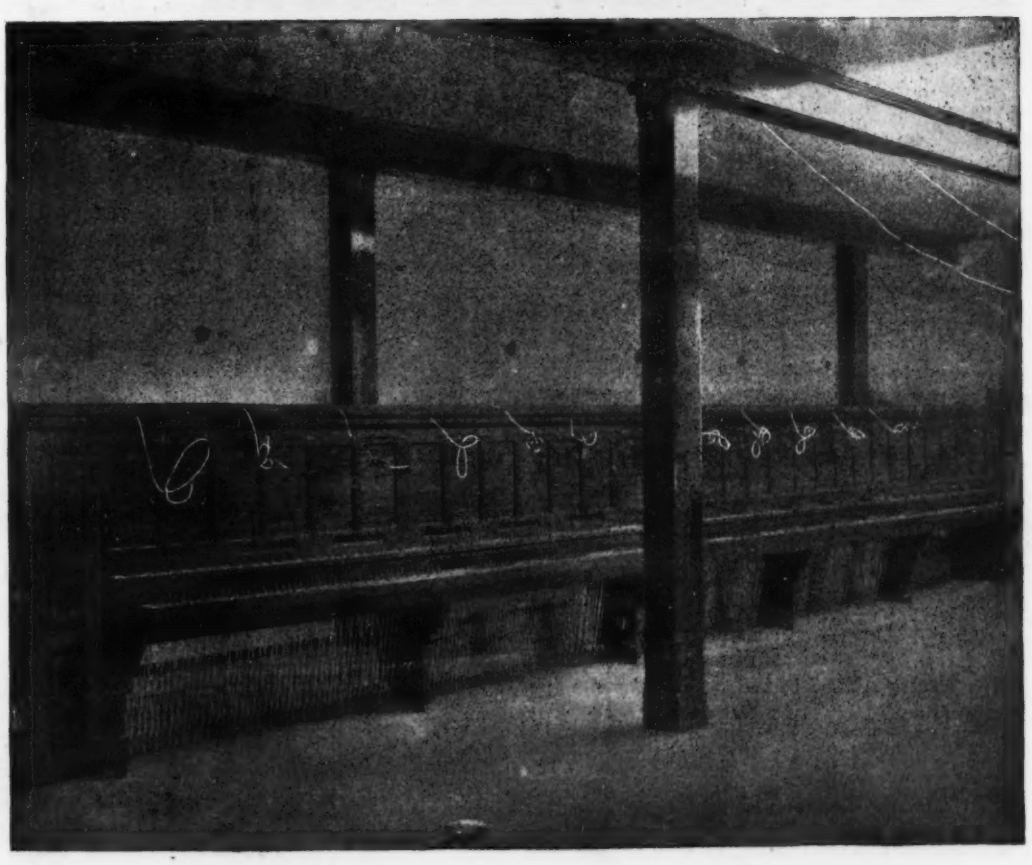
For the central masses of wires the underground conduit is used. The company put down last summer 75,000 feet of underground duct in Hartford. Some idea of the amount of work that has been done will be had when it is stated that there are now under the surface of the streets in Hartford more than 500 miles of insulated wire, and that when the work is completed there will be more than 700 miles. The cables used in Hartford are of what is known as the Faraday pattern, and are made by the American Electrical Works, at Providence.

The underground ducts are of the Phipps cement-lined iron pipes, laid in a matrix of cement, and running into manholes at the corners of the streets. The manholes of the company are all six feet square on the inside, built of 12-inch brick walls, laid up in cement and topped with heavy cast-iron covers. From these manholes the cables are led through lateral ducts to the upper part of the company's









THE TELEPHONE EXCHANGE AT HARTFORD, CONN.

poles, where they enter cable boxes and are distributed as needed to the subscribers.

In addition to the underground work this change of system involves an entire renewal of the overhead construction of the exchange, and this is now going on, the specifications being of the most approved character. The wires are of copper. There is a free use of cables and covered wire in difficult or dangerous places, and the equipment of the subscribers' station will be largely new. This work, aside from the building, will cost the company $60,000 or more, so that its total expenditure in this one exchange will be over $100,000.

Commercial Measurement of High Insulation Wires.

BY CARL HERING.

Although the measurement of the insulation resistance of a wire is a comparatively simple matter, it is by no means as simple to find the most convenient disposition of the apparatus and connections in order to make many successive tests with rapidity and reliability as, for instance, in a wire factory, when the same apparatus must also be used for other tests of the wire, such as capacity, conductivity and locating faults. Each of these tests is comparatively simple by itself, but the disposition of the apparatus and the connections are so very different that a change from one test to another requires an entire rearrangement of the apparatus; and in the wilderness of wires at the testing table it requires time and a very clear head to avoid making a wrong connection, which would give false results or injure the apparatus. When many wires have to be tested, as in an insulated-wire factory, the time lost in arranging and rearranging the connections for different tests becomes important.

Some years ago the writer had occasion to design and put into operation a testing laboratory for a large insulated-wire manufacturing company,* in which the object was to make all four of these measurements with as great facility and rapidity as possible and with the least amount of duplication of apparatus and changes in the connections. The problem was rendered more difficult by the fact that the wire had exceedingly high insulation and therefore required very sensitive apparatus, itself highly insulated, and a high-potential battery, a shock from which was so violent that it would be exceedingly unpleasant, if not dangerous, to the operator, therefore necessitating care that the operator would not have to touch the circuit itself. Besides these principal requirements there were others of more or less importance which were desired, such as facility in calibrating the galvanometer for the insulation and capacity tests, protecting the galvanometer from an accidental injuriously large current, bringing the deflection always to the same direction, dampening the oscillation, protecting the assistant from a shock at the cable when disconnecting the leads after the test, etc. With so many conditions and limitations, the problem was not a simple one. After trying numerous combinations for the connections, the system described below was found to meet all the requirements, and was the one finally adopted.

The four tests to be made are as follows: Insulation resistance and the accompanying calibration of the galvanometer (usually termed "finding the constant"); capacity and the accompanying calibration; locating faults in a reel; and lastly, measuring the conductivity of the copper wire used. The simple diagrammatic connections in each one of these four measurements are shown in Figs. 1, 2, 3 and 4. For the insulation measurement, Fig. 1, the battery, galvanometer, known resistance R (100,000 ohms) and cable are connected in series; by short circuiting the cable leads, b, the galvanometer is calibrated; then by unplugging the cable leads, b, and short circuiting the resistance, R, the cable insulation is measured. The connections for the capacity measurement, Fig. 2, are quite similar, substituting the condenser at a for the resistance and introducing a discharging wire, and the necessary discharge key. The connections for locating faults, Fig. 3, are totally different; the two ends of the copper of the cable are connected to the two ends of a Wheatstone bridge wire, $W\,B$, thus forming with this bridge wire the four arms of a simple Wheatstone bridge, of which the fault in the cable—that is, the internal contact between the copper and the lead coating (or water bath)—forms one of the terminals of the bridge to which the battery is attached as shown. The details of this test will be further discussed below. The connections for the conductivity test, Fig. 4, are those of a simple Wheatstone bridge, including a known standard resistance, R.

The combination of all these connections for all four tests, and including all the accessory apparatus, is shown in Fig. 5. In this all the connections at the testing table are permanent; not a single connection need be changed in going from one test to another, all changes being made solely by means of the plugs on the resistance box. Furthermore, no piece of apparatus is duplicated. In one case only it was preferable to disconnect two long leads when not in use, merely to eliminate a small error which would otherwise be introduced, owing to the inductive capacity of these leads, to the slight leakage through them, or to their possible contact with the floor or walls at their distant ends. This arrangement of parts requires, therefore, merely the plugging or unplugging of two out of the four infinity plugs on the resistance box to change over from one test to another. With such simple changes the possibility of making a mistake in the connections is practically eliminated.

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The name of each piece of apparatus is given on the diagram, and therefore needs no further mention. A detailed description of some of the apparatus which was specially constructed for this purpose—namely, the battery and the meter bridge—will follow the description of the tests. Four very well insulated leads numbered I., II., III. and IV. in Fig. 5 were laid from the testing table to the cable room, about 100 feet distant; there was also a speaking tube for giving signals and communicating. For insulation and capacity tests, leads III. and IV., which are not in use, were disconnected from their terminals C and D at the box, merely as a precaution, because their insulation resistance and their capacity might introduce very slight

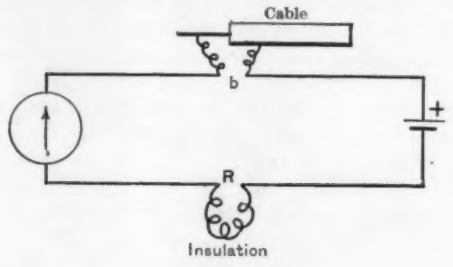


Fig. 1.

errors, and their free ends in the cable room might come in contact with the ground. Except for these reasons, they might be left permanently connected.

Insulation Test.—To get the constant of the galvanometer, plug up b and a, thus cutting out the cable and condenser, and unplug all the others. Use 10 cells by turning the battery switch. Depress and lock the trigger key, which in this test is a mere battery key, and which merely closes the circuit. The galvanometer key merely shunts the galvanometer, thereby keeping it at zero when not in use, protecting it from an accidentally large current, and enabling one, by proper manipulation, to "catch" the deflection and bring the needle to rest more quickly. The reversing key is set at the beginning of each test so that the deflection is always in the same direction. The constant is thus obtained with 10 cells, 100,000 ohms, and the lowest resistance shunt. To measure the cable insulation, unplug b, switch over to 200 cells, and then proceed as before. Note the time when the trigger key is depressed in order that the reading may be taken at the end of one minute, or any other desired and fixed time. Owing to the possibility that the cable may be a bad one, it is best to try it with 10 cells first, and with the lowest resistance shunt, leaving the 100,000 ohms in circuit; if it is good, there will be no appreciable deflection, but if bad, there will be a deflection which, however, can never exceed that obtained in taking the constant, and the nearer the deflection is to the latter the nearer the fault is to a dead cross. By proceeding thus, the galvanometer and battery are protected from injury should the cable be bad; furthermore, the extent of the fault is also given thereby. If it is a good cable, proceed to cut out the shunts and to plug up the 100,000 ohms provided it is of sufficient importance to affect the total resistance. This

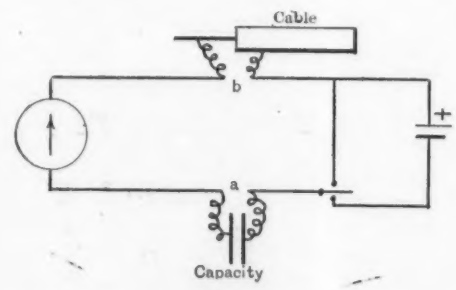


Fig. 2.

takes but a few seconds, so that by the time the minute is over the galvanometer deflection is steady and can be read. When through, release the galvanometer key, "catching" the deflection at zero to stop the oscillations and release the trigger key, which will disconnect the battery and discharge the cable, so as to prevent the assistant in the cable room from receiving a shock on disconnecting the cable, which would be a very violent one from a 400 volt battery, as in this case. Care should be taken to connect lead No. II. to the outside of the cable, or to the tank, as that lead represents the positive pole, which in cable testing should always be the ground pole. Care should also be taken not to touch the metal parts of the trigger key, as a violent shock will be obtained if the operator is grounded, as is generally the case.

It will be noticed that the galvanometer, its accessories and its key (which is the only one touched during the reading of the deflection) are all on the ground side of the circuit, so that there will be no tendency to leakage through them or the operator. If they were on the other side of the circuit, the leakage through them, with such a high-tension battery (400 volts) and such high-insulation cables (up to 100,000 megohms), may become greater than that through the cable. Great difficulty was experienced at first on this account, but it was completely overcome by the above arrangement. It requires, however, that the battery be well insulated from the ground, which was very simple in this case, as it was placed on hard rubber "stilts." Another method is to suspend the whole battery shelf from the ceiling by means of oily cords.

It will be noticed that in this system of connections the galvanometer key protects the galvanometer from the first charge which the cable receives, and which would otherwise set the needle into very violent oscillations, requiring more than the limited time of one minute to come to rest. When a "German" scale is used, which has the zero at one end instead of in the middle, as in the "English" scales, it will facilitate the subtractions to have the deflections read *up* the scale instead of *down*. The galvanometer zero should for the same reason be set (by moving the scale) so as to correspond to a simple number, like 10 or 20.

Assuming that the insulation is measured with no shunt and full battery, and that the constant is measured as above described, and with the $\frac{1}{1000}$ shunt, then the constant (viz., the deflection per megohm with no shunt and full battery) will be equal to the deflection × 1,000 × battery ratio (in this case 20) ÷ 10. This constant, divided by the deflection obtained with the cable, will give the insulation in megohms. This latter, multiplied by the length of reel in feet, divided by 5,280, will give the insulation in megohms per mile; or if the mileage of the cable is known, multiply the insulation of the reel by its mileage to get the insulation in megohms per mile.

Capacity Test.—To get the constant, unplug the condenser at a, insert the plug at b, to cut out the cable, and plug up the 100,000 ohms. Use the proper number of cells to get a good deflection, in this case 10 cells, and commutate the receiving key, as the current will be in the reverse direction from what it was for the insulation test. Depress the trigger key, which will charge the condenser, and, after allowing time for this charge, depress the galvanometer key, and when ready to read the deflection release the trigger key. To measure the capacity of the cable, unplug it at b, plug up the condenser at a, and proceed as before, using a different shunt, if necessary. If there is a possibility that the cable is a bad one, it is best to proceed cautiously by unplugging the 100,000 ohms before closing the circuit. If in a few seconds after closing the circuit at the trigger key there is no appreciable deflection in the galvanometer on depressing the galvanometer key, then the cable is not bad, and the 100,000 ohms resistance may be plugged up while waiting for the cable to take its full charge. There is no practical way of "catching" the oscillations after the deflection has been read, and it is therefore advisable to let this test follow that of the insulation, instead of preceding it, so as to give the needle time to come to rest while the assistant connects on to another cable. The galvanometer key, being, when closed, a short circuit for the galvanometer, will tend to act to a slight extent to dampen the oscillations.

It will be noticed that the galvanometer key takes an important part in this test, as it prevents the *charge* from deflecting the needle, and therefore keeps the needle at rest, ready for the discharge deflection. The trigger key, as usual in such tests, prevents any loss of time taking place between the time the battery is taken off and the discharge. It is desirable in this test to have a condenser divided into tenths of a microfarad, and to unplug for the constant such a capacity that by merely changing the shunt the deflection for the cable will be about the same as for the constant, thus enabling the same battery to be used for both. To do this it must be known, of course, about what the capacity of the cable is before taking the constant. This may be done by measuring the cable first and taking the constant afterward.

If the constant was taken for the one-tenth of a microfarad, then the capacity of the cable in microfarads (if measured with the same battery) will be equal to the cable deflection divided by the constant multiplied by .1 microfarad, and corrected for the shunt if a different one has been used. Or, for convenience in calculation, the reciprocal of the constant may be calculated once for all, and then used as a multiplier instead of a divisor. To reduce this to the capacity in microfarads per mile, multiply the capacity thus obtained by 5,280, and divide by the length of the reel in feet; or, if the mileage of the cable is known, divide the capacity by this mileage. If a different battery was used for the constant and for the cable the necessary correction must of course be made; but it is very desirable to use the same battery as described above, so as to avoid having to make this correction.

Locating Faults.—On the testing table all the changes necessary are to unplug a and b, plug up all the resistances and connect the leads III. and IV. to c and d, respectively, just as the condenser is connected; the condenser may be left in if desired, but there must not be any plugs in it, and it must not be grounded. In the cable room the two ends of the reel are connected to the ends of the meter bridge wire, as shown in Fig. 5. These connections should preferably be made directly, and not by means of leads, even short ones, unless the joints are quite perfect. The fine wire leads I., II., III., IV. are connected to the cable and bridge as shown; their resistance and that of their joints are of no importance. Care should be taken to have the positive pole to ground, as shown, by using lead No. IV. as a ground wire; otherwise a fault may be sealed up while it is being located·

The whole will constitute a Wheatstone bridge, of which the fault to be located is the fourth contact, the four leads being merely the connections to battery and galvanometer in the testing room. Depress the trigger key first, and then the galvanometer key; and if there is a deflection the sliding contact on the bridge must be moved to the right or left until no deflection is obtained. From the reading on the metre bridge and the length of the cable the position of the fault is then readily determined. There must, of course, be some means of communication between the operator and his assistant.

Among the details of the test besides those above mentioned are the following: For a low-resistance or dead fault, use a low-resistance battery capable of giving somewhat more current than the usual batteries for insulation tests. The trigger key should be depressed only long enough to take a reading of the galvanometer; otherwise the battery may become discharged or polarized, as the external resistance is quite low. The reversing key may for con-

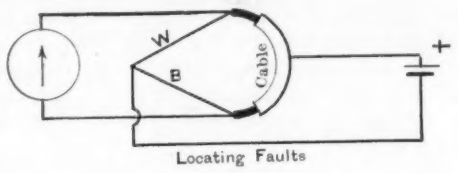


FIG. 3.

venience be set so that deflection on the increasing side means that the bridge contact should be moved so as to increase the reading, and *vice versa*. The bridge should for convenience be graduated to 1,000 parts; the one used was one metre long divided into millimetres. The resistance of this bridge wire should be about equal to that of the average cable to be tested, in order to give the best results. The sliding contact on the bridge was so designed that the contact had to be lifted before it could be moved along; this was done so as to avoid scraping or flattening the wire when using the bridge. This contact was furthermore constructed so that on lifting the sliding contact the circuit was first broken at another point, in order that the spark (which may become quite great) does not occur on the resistance wire, and therefore the latter is not injured by it. For convenience in calculating the result, the outside end of the reel is connected to the zero end of this wire, and the inside end to the 1,000 end; the figure obtained will then give, directly, the length of cable which must be unreeled in order to get to the fault. This length will evidently be equal to the length of the cable multiplied by the reading of the bridge in millimetres and divided by 1,000, because, being a bridge, the distances from the fault to the two ends will be proportional to the distances from the sliding contact to the two ends of the bridge. Faults have been located in a number of instances in a No. 4 wire to within a few feet of their true value, the whole length of cable being almost half a mile. This method, therefore, admits of getting very good results. The only difficulty experienced was when the fault had a high resistance, in which case the cable should be connected to the negative pole of a dynamo or battery the positive pole of which is connected to the outside; and it should remain so connected until the fault has become one of low resistance, after which it can be located. A faulty cable being the exception, this adds very little to the work. For high-resistance faults it may give better results to exchange the battery leads with the galvanometer leads, but in that case it is very important that the battery should not be grounded, and that it should be very well insulated; the

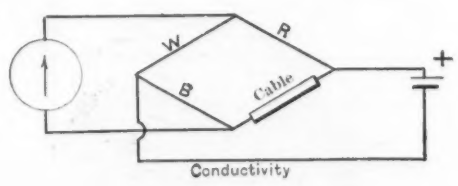


FIG. 4.

battery in that case need not be of higher voltage than for a low-resistance fault, because the main current does not have to pass through the fault itself.

Conductivity Test.—The connections and the bridge for this test are precisely the same as those for locating faults, only that the cable is connected in series with a known standard resistance *R* (Fig. 4), and the junction of the two takes the place of the fault, and is therefore connected to the end of lead No. IV. This standard resistance had better be of copper, so that no temperature correction is required. Furthermore, its resistance ought to be about that of the average cable to be measured, in order to give the best conditions for making the test. If an appreciable current is used, the standard resistance should not be made of too fine wire; for the best conditions its size should not differ too much from that of the cable. The measurement is made just like the preceding, and the reading of the bridge gives the ratio between the standard resistance and the cable, and therefore gives its actual resistance, from which, together with its size, the conductivity may be calculated.

Special Apparatus.—Besides the bridge already described above, the only special apparatus used in this laboratory was the battery. This consisted of 200 Planté accumulators, and therefore gave about 400 volts. The cells themselves were made of small glass tubes or vials placed in 20 rows of 10 cells each. The ends of each of these rows were connected to the well-known Planté form of cylindrical commutator, which by a single half turn enables the cells to be connected either all in series, or 10 in series and 20 in multiple arc. The plates themselves consisted of a lead wire bent into the form of an inverted U, and having one arm in each of two adjacent tubes. They may be kept insulated from each other in the tubes by packing the cell with coarse, well-washed sand. The cells are charged by turning the commutator so that they are coupled 10 in series and 20 in multiple arc, and then connecting them the day before with about 20 or 25 Leclanché cells. When power can be obtained it is preferable to use a small shunt wound motor, such as may be found in the market, and run it as a dynamo. The resistance of such a battery is very low and may be neglected. It is important, however, for this reason, that care should be taken not to touch the circuit when the cells are all in series, as the shock obtained is very violent. It is also necessary to guard against any accidental short circuiting of the battery, as this discharges it. The battery may be placed next to the operator, as it occupies but a small space (two square feet). It was insulated by placing it on four "stilts" of hard rubber rods three or four inches long. When the battery is in good condition the electromotive force of the 200 cells may be taken as exactly 20 times that of the 20 groups in multiple, and therefore the battery ratio need not be determined by a test.

The galvanometer was adjusted in sensitiveness so as to give a full deflection for the calibration with the 100,000

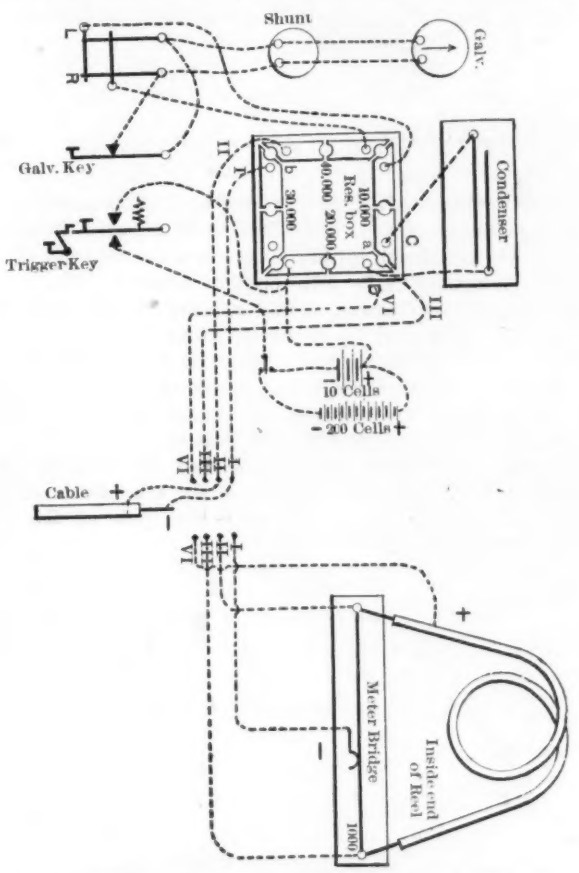


FIG. 5.—CONNECTIONS FOR CALIBRATION, INSULATION, CAPACITY, LOCATING FAULTS, CONDUCTIVITY.

ohms and 10 cells. The average resistances to be measured were between 20,000 and 30,000 megohms, though in one case a resistance of 108,000 megohms was measured. The deflections were read with a telescope and scale, as this was found preferable in many ways to the spot of light method. The galvanometer was at a distance of about six feet from the scale, which is double the usual distance. It was of the double-coil Thomson type, made by Carpentier, in Paris. To avoid being affected by the continual trembling of the ground it was placed on a very heavy slab of marble four inches thick, suspended on three wires fastened to a pier. This overcame completely the vibrations, but it is important not to touch the galvanometer itself, as it will oscillate as a body for hours when touched. A little wad of soft paper or cotton placed between the slab and the pier, so as to cause some friction without transmitting vibrations, will tend to bring the slab to rest more quickly.

It was found that with such high voltages and such a delicate galvanometer there was what appeared to be a sort of static charging of the needle and its mica damper, the effect of which was to cause the needle to make very erratic and violent movements, rendering the instrument utterly useless. This took place even when connected to only one pole of the battery. After futile attempts to overcome this, it was finally accomplished very satisfactorily by connecting the galvanometer circuit to the frame of the galvanometer itself. This, however, required the galvanometer to be insulated, which was done by placing it on "stilts," like some of the other instruments. After all these precautions were taken the results were very satisfactory in every way.

Although the insulation test described above is the one generally used, it should be remembered that, although it will answer in many cases, it does not by any means prove that a lead-covered cable is good; for suppose that there was no insulation at all for a foot or two, and that by mere chance the copper did not touch the lead coating—the cable would test high, but it would be faulty in the worst way. To detect faults of such a nature an influence machine or a Ruhmkorff coil giving a spark of, say, one inch might be used. This would merely indicate whether there was a fault or not, but would not measure its resistance.

The Phonopore.

A marvelously ingenious bit of apparatus is that described below. Apparently complicated, yet decidedly simple in detail, it is intended to serve as an adjunct means of

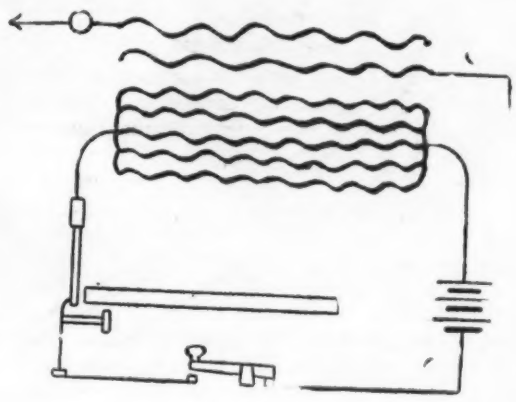


FIG. 1.

telegraphing over a line already in use, and as a matter of fact it permits an ordinary telegraph line to be duplexed with great simplicity, and with the additional advantage that two messages can be transmitted over the same line in the same, as well as in opposite, directions. It is the invention of Mr. Langdon-Davies, who was led to its invention by the disturbances often experienced on telephone lines, even when cut off from earth. The system consists essentially of sending rapidly vibratory induced currents over a telegraph line already in use, and then employing these currents to operate a special relay working an ordinary Morse or other receiver. So far as the vibratory currents are concerned the line is completely insulated, the induction being produced by a special coil in a circuit containing a vibrator.

The phonopore transmitter consists of a circuit containing, first, what Mr. Langdon-Davies calls the phonopore; second, a vibrating reed to produce the oscillations of current desired; and, third, a Morse key. The phonopore itself consists of a primary coil built up of a number of distinct coils connected in multiple arc, and all wound upon an iron core; around this multiple helix is coiled a pair of secondaries insulated from each other, one end of each being left insulated, the other end being con-

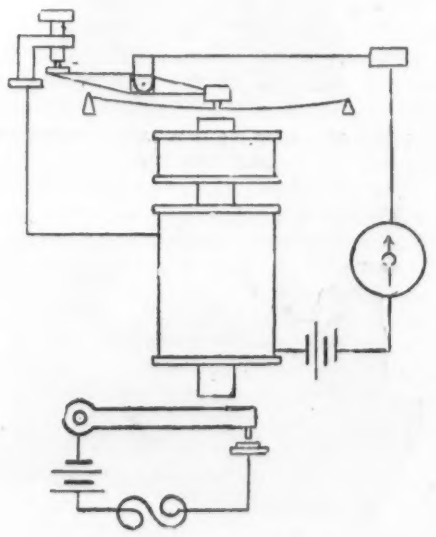


FIG. 2.

nected respectively to line and to earth. Depressing the key starts the reed in the phonopore circuit into action, and produces very rapid induced electrical oscillations on the line. These are of but small intensity and produce no effect on the ordinary telegraph apparatus. Fig. 1 shows this arrangement in diagram and displays the method of its operation. The vibrating reed is tuned to a definite and very high pitch, and is not directly attracted by the long magnetic core shown, but forms a prolongation of the armature proper. This device secures a regularity that is otherwise hard to attain. The receiving station is shown in Fig. 2. The receiver consists in general of a soft iron core upon which are wound two helices, one connected through the line with the transmitting instruments at the distant station, while the other is part of the local circuit, including a battery, galvanometer and a relay. The current passes also through a contact formed by the vibrating reed tuned to the same period as the trans-

mitter and another contact piece supported on a weaker vibrating spring of slow period. When the reed is at rest the contact between it and the vibrating springs is closed, and the local circuit magnetizes the core and thus attracts the reed to a position of equilibrium. If now the pulsatory current of period synchronous with that of the reed comes in from the sending station, the reed will be thrown into violent vibrations, and in so doing it will strike the contact pieces on the weak spring which forms part of the local circuit, thus breaking the latter and throwing the relay into action; this in turn transmits its signal to an ordinary telegraph sounder. Thus at each depression of the sending key the reed is thrown into vibration until it opens the local circuit through the relay. A single impulse, particularly if of period not coinciding with that of the reed, will not operate the receiver, which hence is entirely independent of the ordinary telegraph instruments on the same line. It might be supposed that an appreciable time would be taken in building up the vibration of the reed until it actuates the local circuit, but as a matter of fact the oscillations produced by the transmiter are so rapid that the action is practically instantaneous. Fig. 3 shows the phonopore installation ready for use. It consists of a transmitter, a receiver, and an ordinary sounder or printing instrument. The phonopore system being entirely independent of any ordinary telegraph currents on the same line can thus be used to duplex ordinary lines with entire success; as a matter of fact, recent experiments in England gave good results over a distance of more than 100 miles, the signals being recorded on a Morse printer, although they were transmitted in both directions along a line that was constantly carrying the busy traffic of an important railway service. Unlike the ordinary duplex systems, a line fitted with the phonopore permits the sending of two distinct messages simultaneously in the same direction, as well as in opposite directions. Its scope of operation is not limited by the distance just mentioned, for experiments in Spain have been successfully carried out over a distance of more than a thousand miles. The phonopore system is certainly a wonderfully ingenious one, and promotes good results in the hard test of every-day practice.

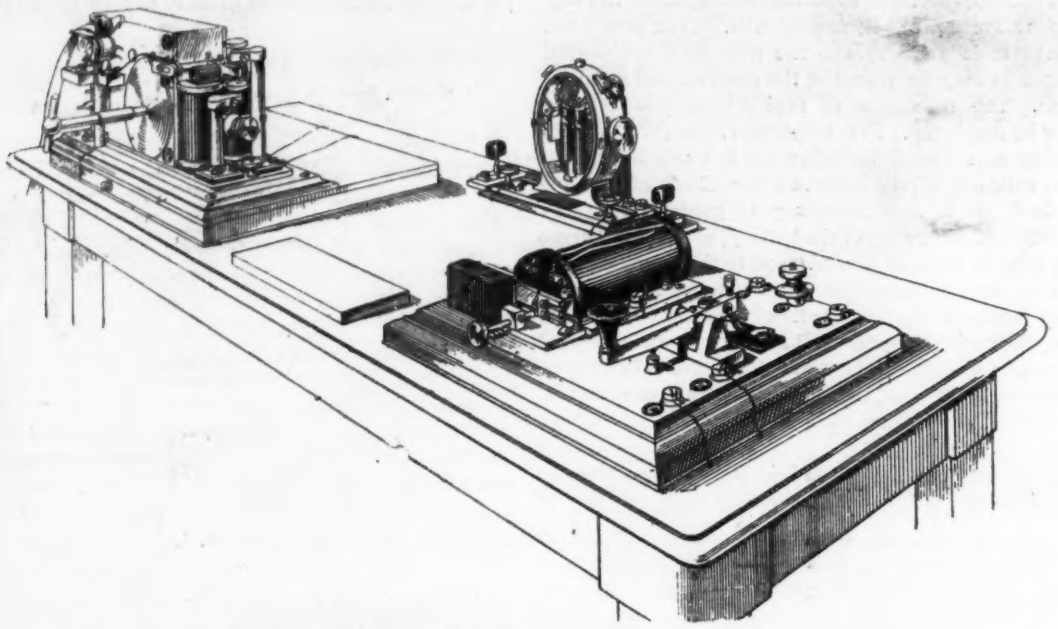


FIG. 3.—PHONOPORE INSTALLATION.

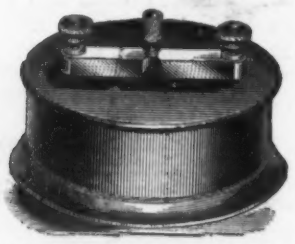


FIG. 47.—ONE-THIRD MICROFARAD CONDENSER.

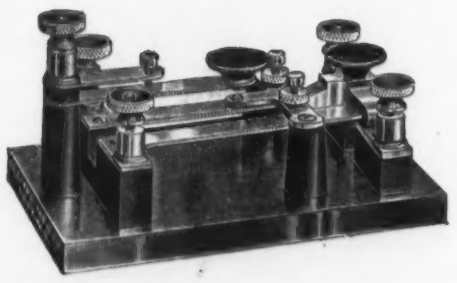


FIG. 49.—KEY FOR CAPACITY TESTS.

The Construction and Use of Electrical Testing Apparatus.

BY CHARLES P. FREY, CHIEF ELECTRICIAN OF THE GREELEY ELECTRICAL LABORATORY.

XII.

Capacity Comparisons.—A farad is the unit of capacity, and a condenser has a capacity of one farad when a potential difference of one volt between its two sets of plates charges each of them with one coulomb. A farad being rather a large unit of capacity for ordinary purposes, one-three-millionth of a farad or one-third microfarad is more commonly employed. This has been adopted because its capacity equals, or formerly equalled, the capacity of one knot or nautical mile of the original Atlantic cable.

Standard condensers, as illustrated by Fig. 47, which may be had of any capacity required, from $\frac{1}{10}$ to 1 M. F., are constructed of tinfoil and mica, and are standardized by comparison with a condenser whose value has been determined in absolute measure, and which has also been calibrated at the Electrical Testing Bureau.

The capacity of a condenser can be determined in various ways. In the method shown the two condensers are charged simultaneously from one pole of the same battery, high resistances having been interposed in each branch. They are then discharged against each other through an astatic galvanometer. An equilibrium is established, and their respective charges neutralized, when the *potential rises at an equal rate in both*. Then the capacities are *inversely proportional* to the *resistances* through which they were respectively charged.

X and "St." represent two condensers whose capacities are to be compared. (Fig. 48.) Arrange all connections as shown, using well insulated and, when it can be obtained, rubber-covered wire. Nos. 14 or 16 are the best. None of the wires shown in the illustration must be connected together where they cross on the diagram, but on the contrary should not even touch each other if it can be avoided, as they may leak through the insulation.

A resistance box having a range of from one ohm to 5,000 ohms will be found very convenient in making this test. When the capacity of a submarine cable is to be determined, it takes the place of X. Eight or more Daniell or Leclanche cells should be used, and a form of Lambert's key shown in Fig. 49.

Insert all plugs except the infinity and the two 1,000 ohm. Short circuit both condensers to get rid of any residual charge. When ready for a test, take the plugs out of the condensers and insert the infinity plug in the box. Depress the key *A* at once. Hold it down for several seconds, or else push the vulcanite wedge toward *B*, thereby securing permanent contact until the wedge is withdrawn. When the wedge is removed the springs again press against the upper contacts, and since the latter are in the same piece of metal the two opposite charges will combine, and what charge remains will pass through the galvanometer, when the key *B* is depressed.

Watch the galvanometer deflection and note its direction. If all the connections are correctly placed, and both condensers are in good order, and there is no movement of the galvanometer needle, the two capacities are as 1,000 : 1,000, namely, equal. If a deflection is obtained, the resistance between *C* and *E* must be reduced until an opposite deflection from the first is secured. Then, by using intermediate resistances, an equilibrium will be quickly obtained. When the needle no longer moves, the capacity of X is to the capacity of the standard as the resistance unplugged is to 1,000.

For instance, if the resistance unplugged is 750 ohms, the capacity of X will be $\frac{750}{1000}$ of the capacity of the standard, and if the standard is a $\frac{1}{3}$ M. F., the capacity of X will be $\frac{750}{1000}$ of $\frac{1}{3} = \frac{750}{3000} = \frac{1}{4}$ M. F.

If X proves to be greater than the standard, the positions of the standard and X must be interchanged. Always short-circuit the condensers after each test and when not in use, and remove the infinity plug.

A resistance box arranged specially for condenser work, having coils with wire of large diameter, can be had of the makers of the condensers.

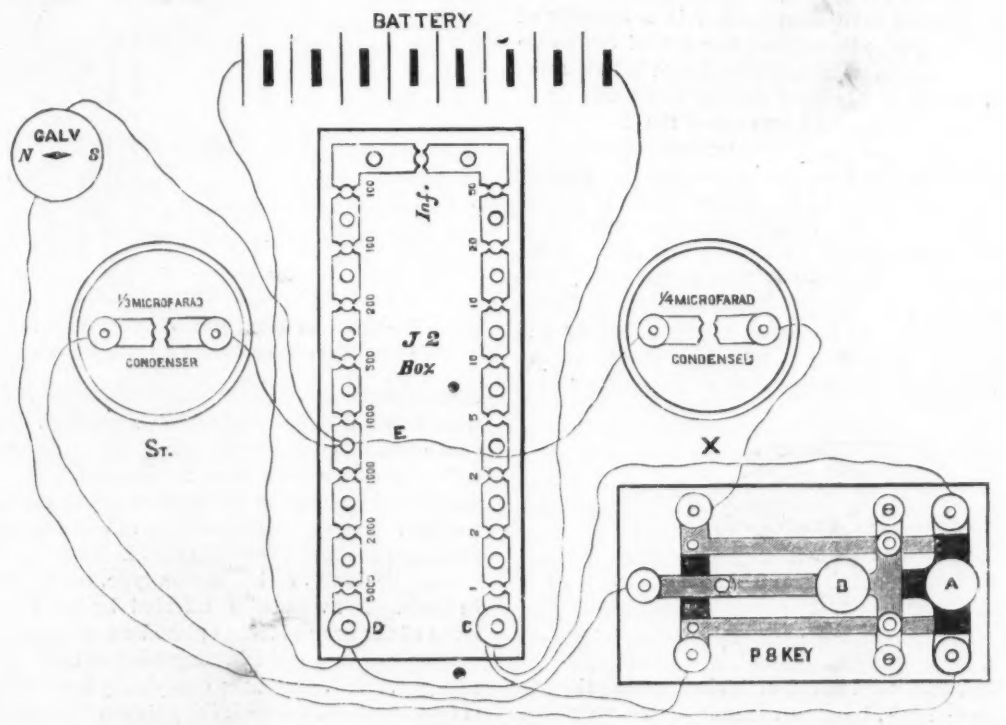


FIG. 48.

The Smoking of a Ceiling by Incandescent Lamps.

BY A. B. UPHAM.

Why does an incandescent light "smoke" the ceiling? Such fact has been noted by the users of electric lights, but no reasonable explanation has been thus far offered.

A gas jet located near the ceiling always darkens the surface above, and it is readily believed to be owing to the particles of unconsumed carbon emitted from the flame. But when an incandescent light similarly placed does the same thing, we become slightly perplexed. Most of us hesitate to believe in the power of the carbon particles from the filament to pass through the air-tight bulb and "smoke" the ceiling above, although this explanation has been soberly advanced in some electrical journals.

A little observation is of assistance in all such matters. Let us therefore note one or two other facts. First, almost every one must have noticed in old houses that they could "see" the lathing in the ceiling of the rooms. Very frequently, also, the positions of the joists themselves can be readily made out. What is the reason for this?

One more fact will perhaps give us the clue. In a certain room there is a strip of muslin secured over an opening into the chimney. The portion of the cloth immediately in front of the hole has been turned nearly black with dirt. By removing the cloth and holding a match at the opening, a strong upward draft is found. Hence the dirt cannot come from the chimney, but is nothing more than the dust sifted by the muslin from the air-current passing from the room up into the chimney-flue.

It is more than probable that the plastering acts as a sim-

ilar sieve to collect the dust from the weak but continuous currents of air passing through the ceiling. The laths and joists serving as partial barriers to the air currents, the plastering immediately beneath them is less blackened, and the ceiling marked accordingly.

It now becomes almost a certainty that it is the dust from the surrounding air which "smokes" the ceiling above an incandescent light. The heat from the bulb causes a great increase in the uprising air-currents immediately surrounding the light, and accordingly more dust is deposited above it than elsewhere.

If some chemist or microscopist will analyze the deposit upon the ceiling, he can soon settle the point.

The Westinghouse Four-Pole Railway Motor.

We give herewith a full description of the new four-pole slow-speed motor of the Westinghouse company in the form in which it is now ready for the market. It will be instructive to compare this with the experimental form which we illustrated last week and see the points in which the newer machine has been improved. More especially is to be noticed the cylindrical form of the field castings, making a more compact and symmetrical magnetic circuit. Fig. 1 shows a general view of the new motor closed in its casing and ready for business.

It will be seen that its general form is cylindrical, giving both the shortest possible magnetic circuit and maximum strength with minimum amount of material. Beside this, all the sharp corners that tend to leak magnetism are elimi-

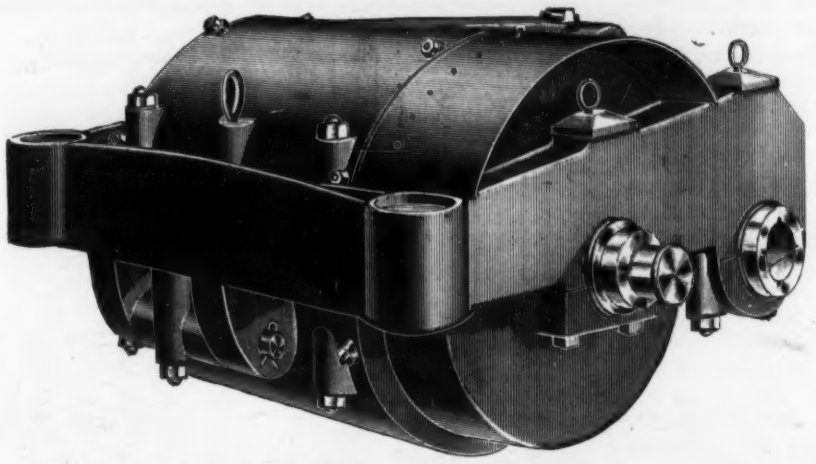


FIG. 1.—GENERAL VIEW OF MOTOR.

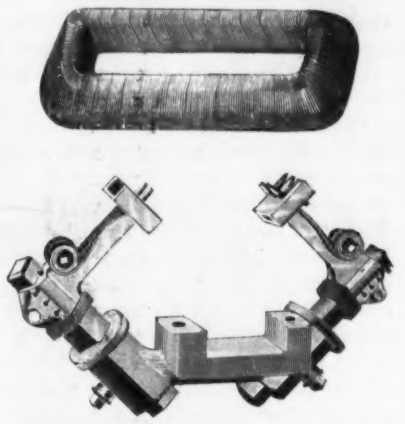


FIG. 2.—BRUSH HOLDER AND COIL.

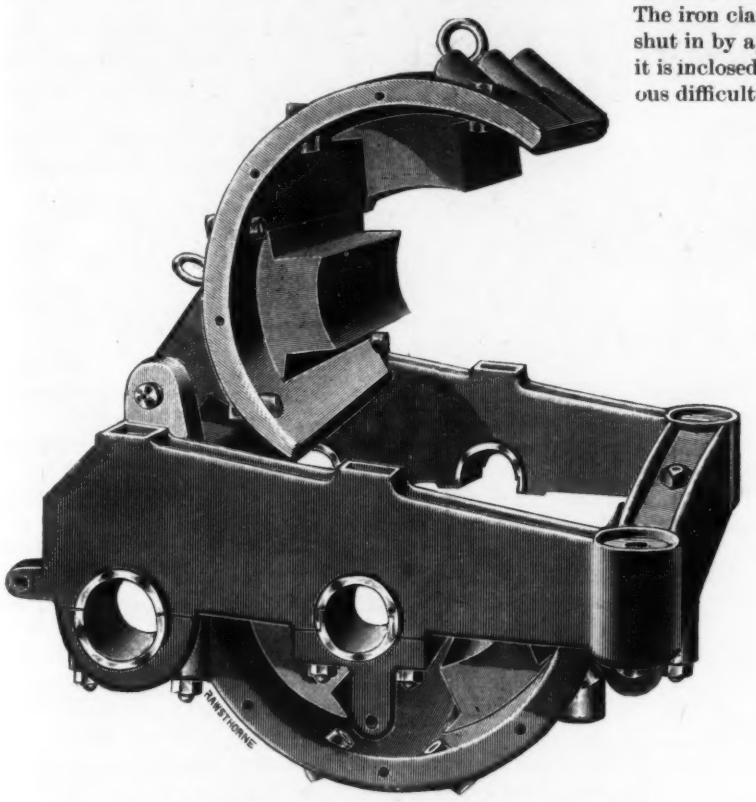


FIG. 3.—MOTOR WITH ARMATURE REMOVED.

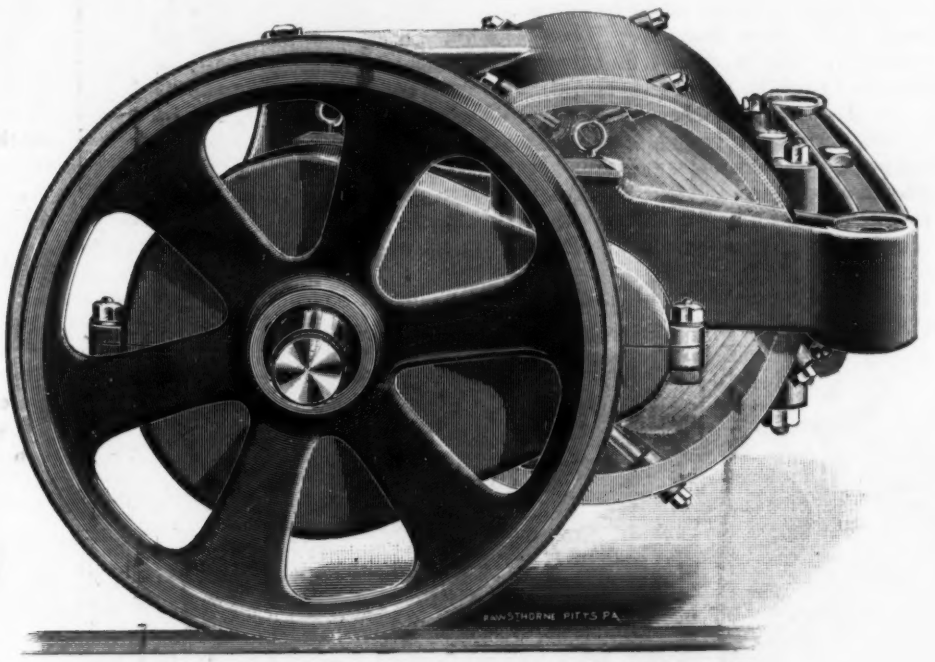


FIG. 4.—GENERAL VIEW OF MOTOR AND GEAR.

nated, and the machine is rendered thereby slightly more efficient. The details of the magnetic circuit are best shown by examining Fig. 3, which shows the casting freed from armature and coils and opened up to exhibit its arrangement. The motor has the same square form of frame that is already familiar in the Westinghouse motor of last season. But the change in the form of the magnetic circuit makes it possible to utilize four poles with great advantage, and they are, as will be seen at a glance, rather narrow, and consequently are capable of being magnetized by comparatively short and small windings. One of these coils, together with a brush-holder, is shown in Fig. 2. The brush-holder is a solid-looking casting bolted on to the lower side of the main frame of the motor, and lifting its brushes quite on to the top of the commutator, where they rest 90 degrees apart. The field coils are of coarse wire, and, by reason of their small length and low resistance, give the necessary magnetization without a serious loss of energy. The castings are of a specially soft grade of iron that has proved to have excellent magnetic properties.

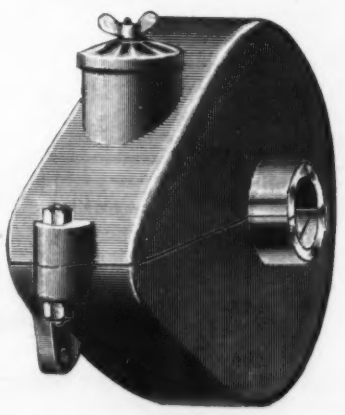


FIG. 5.

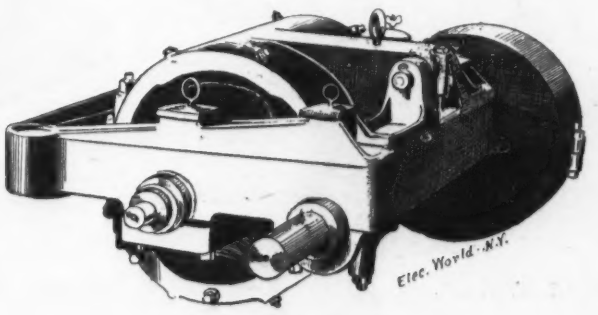


FIG. 6.

Fig. 4 gives an excellent idea of the general arrangement of the motor, showing the gear casing—exhibited by itself in Fig. 5—the arrangement of the fields and the disposition of the frame supported as usual on the axle at one end and flexibly at the other. The gearing, inclosed as it is in an oil-tight case, is always thoroughly lubricated and free from dirt. All the bearings are bushed with metal, and the armature shaft is slightly tapered to facilitate the removal of the pinion. The gear ratio is 3.3 to 1. The iron clad form of the motor enables it to be completely shut in by applying side plates, so that in actual practice it is inclosed so tightly as to be quite free from the numerous difficulties so often experienced from dirt and moisture finding their way into the working parts of a machine. As the lower surface of the motor presents only a solid casing it cannot be injured by casual blows from projecting rubble, a source of difficulty with which electric street railway men are only too familiar. Fig. 6 gives a perspective view of the motor, showing its arrangement in the frame and connection to the gears. The armature of the new machine is of the drum type. The core is built up of grooved iron plates, so that the windings are inside slots upon its surface, thus completely imbedded in insulating material. The surface of the finished armature is therefore entirely smooth and the clearance space very small. Even should the bearings become worn so that the armature would brush against the pole pieces, no serious damage would be done because no wire is exposed. Special precautions have been taken in the insulation, so that in the experimental work we are informed that not a single coil had burned out.

The electrical efficiency of the motor is said to rise to 95 per cent., and the commercial efficiency to 75 or 76. This is an excellent showing and displays the slow-speed motor with a single gear reduction in a very favorable light. It is about the figure that would be expected from a machine of this construction. Inasmuch as the efficiency of the two-pole motors of various makes with the complicated gear is generally held to be a little over 60 per cent., the abolition of the intermediate gear ought certainly to be good for more than 10 per cent. increase in efficiency. The normal speed of the armature at a car speed of about 10 miles per hour is 380 revolutions per minute. Thus it will be seen that the machine in question is really a very slow speed motor, the result of good magnetic circuits and the four-pole construction. The commutator is designed with special reference to obviating the heating that is sometimes so disastrous in street car motors. Each segmen of the commutator has a bearing along its entire lower edge, so that even if there should be any slipping the symmetry of the commutator would not be destroyed. The cross-section of the armature enables the two brushes, as before mentioned, to be placed 90 degrees apart, and both upon the top of the commutator, where they can be readily inspected or replaced if necessary.

The new machine certainly has given a good account of itself experimentally, and the advantages of its construction are obvious. The very valuable feature of hinged magnetic circuits, so that the armature and fields can be readily removed, will be greatly appreciated by every street railway man, and there is every reason to expect that the new machine will give a good account of itself when put to the test of extensive use.

Electric Wires in Pittsburgh.

Captain Morris Mead, chief of the Pittsburgh, Pa., Bureau of Electricity, has submitted his seventh annual report. In speaking of the new police and fire-alarm telegraph system of the city, Mr. Mead says that in its construction the first attention was paid to the building of the lines and boxes, the matter of the inside central office being thought one in which defects could be more readily gotten at, an operator always being on hand at the station to look after the system; while, if anything goes wrong on the line a good dea of work may be involved in tracing it up. In consequence, the completed system is very effective, and Mr. Mead feels proud of the result. Several suggestions are made with regard to provisions for safety in connection with electrical railway lines, among them being one that the voltage should not be allowed to exceed 550 volts. This is a suggestion that has been made in many other cases, and in nearly every city now operating an electric railway the standard voltage is between 500 and 600.

Notes on Secondary Batteries.

BY DR. I. KITSIE.

In a recent issue of THE ELECTRICAL WORLD appeared a description of a secondary cell, the invention of the celebrated French electrician, Emile Reynier. The article after stating that the normal rate of discharge is from three to six ampères, closes with the statement that "the battery is very solidly constructed in view of its employment in electric tramways or similar works. The erroneous impression that the normal rate of discharge for secondary cells used for traction purposes is only of secondary importance seems to be prevalent not only here but also on the European continent.

Electrical engineers figure to their own satisfaction and that of the investors that a cell which gives, say, 180 ampère hours will run for nearly five hours, a car needing an average of only 40 ampères, and are astonished to find that after two trips the "thing" will not work. They are also disappointed, and the investors go even further and lose faith in the "new wrinkle" entirely, because the cells, after a few weeks' run, become useless. I have seen cells, the normal discharge rate of which was given at 15 ampères, placed on cars and worked with an average discharge rate of 35 and extreme discharge rate of 90 to 100, and then the inventor, the investors and the managers complaining because the cells gave only 40 per cent. of their capacity and even disintegrated after a few weeks' work.

Last summer I had occasion to experiment in the direction of finding the relation between resistance, normal discharge rate, capacity and actual ampère hours at different discharge rates. I may at a later day go more fully into the subject, but I will state here for the benefit of those interested in electric traction that the normal discharge rate of a cell is one of the characteristics upon which depend a great part of success or failure.

A secondary cell can in that respect be compared with a beast of burden. A horse cannot be overworked without an actual loss. Current cannot be taken out of a cell at the rate of 40 if the normal discharge is only 15 without an actual loss. Take the average cell in the market, with its capacity of 150 ampère hours at the discharge rate of 15, and place it on the car, and it will not be possible to get out of it more than 80 ampère hours. Of the other 70, one-half is a dead loss and one-half is only available at a low discharge rate.

Let the Reynier cell, with its discharge rate of three to six ampères, be placed in such a car, and the result will be a dismal failure, adding more disrepute to the already abused system of electric traction with secondaries.

To guard against such an undesirable event is the aim of this communication.

Wheeler's Double Trolley System.

The public interest in the various means for obtaining rapid transit in this city is evidenced by the numerous articles appearing in the daily papers; and while surface roads in our streets cannot, for obvious reasons, be practically operated to give the rapidity of transit desired for long distances, it is conceded that the application of electricity as a motive power to the street cars would aid in the solution of the difficulties.

In double trolley systems no earth return is employed, and the parallel wires avoid the effects of induction in telegraph or telephone wires that may be located near by.

The public objects to the appearance of overhead wires along the centre of a street, and where elevated railroads exist the officials of the roads object to giving the use of their structures to support conducting wires for a competing surface road.

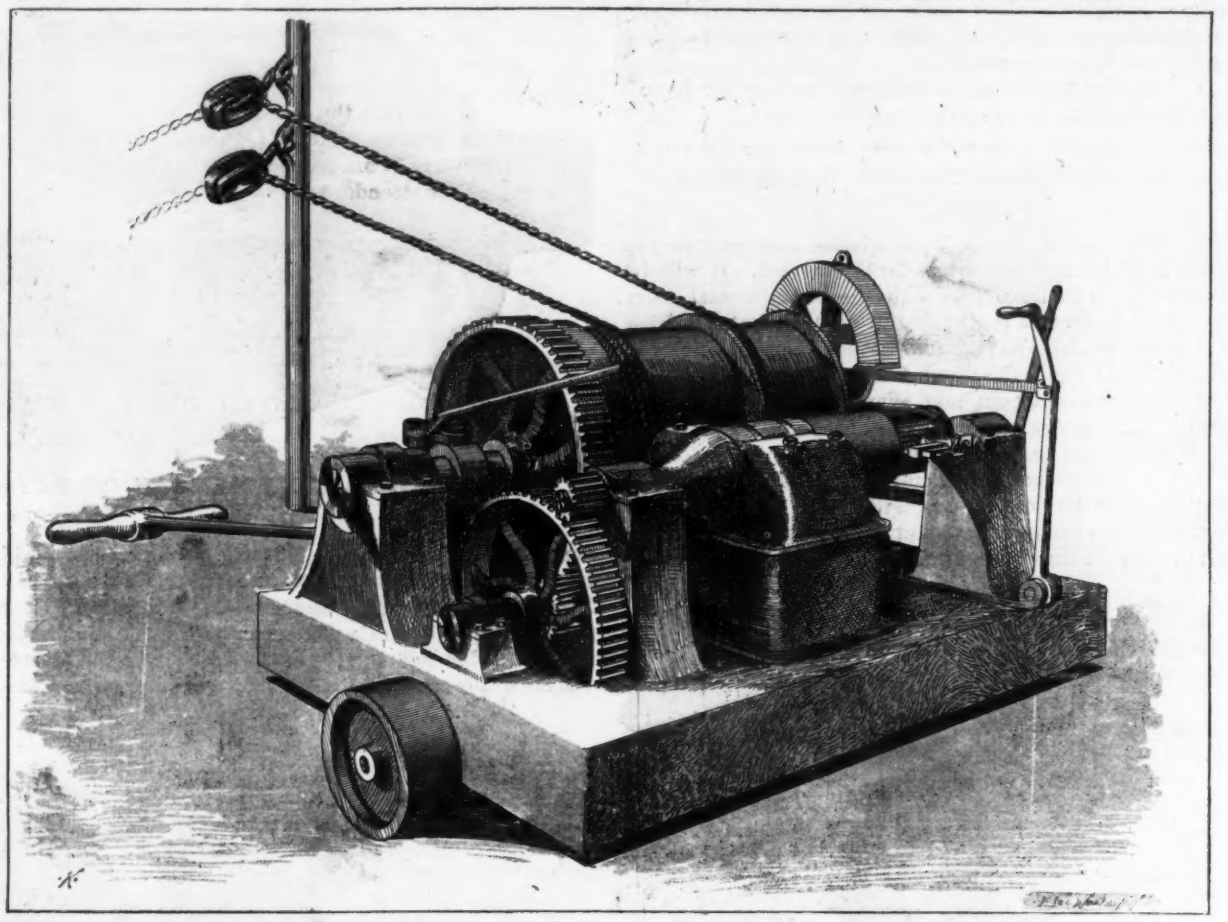
Mr. Frank Wheeler, of Meriden, Conn., some of whose inventions we illustrated in THE ELECTRICAL WORLD of July 12, 1890, presents some suggestions of a construction for avoiding these objections. In the illustration two overhead wires are strung along the side of the street and protected from contact with crossing wire or branches of trees by an arched insulating shield, but which latter might be omitted. These wires are to be supported by telegraph wire poles if convenient, or by poles set close to them or to the columns of an elevated structure, where they would be scarcely noticeable. With a four-wheeled trolley, such as illustrated in our issue referred to, the draft of the cord leading to the car may be at almost any angle; and the double conductors for a car on one track may be above the conductors of the other, instead of on the opposite side of the street, as in Fig. 1.

FIG. 1.—WHEELER'S DOUBLE TROLLEY WIRE SYSTEM.

The clip for connecting two conducting wires, as shown in Fig. 2, is not particularly designed for this system, but for any location. Both wires are firmly held in place with their ends bent under the clip by a key that is held in place by a screw.

A Thomson-Houston Electric Hoist.

The Thomson-Houston Motor Company has developed the application of electric power, and is putting out a hoist that has already met with marked success. The Merchants and Miners' Transportation Company, of Boston, has been using one for some months at its dock to assist in unloading cargoes. The accompanying illustration gives an excellent idea of its construction and the work it performs. The motor is of the general Thomson-Houston type, specially wound for 220 volts, of 10 h. p. capacity and is reversible. A small pinion on the armature shaft engages the first large gear; a small pinion on the shaft of this large gear in turn engages the friction gear wheel of the drum itself. The drum is double divided by a raised partition in its centre. The two cables are wound in opposite directions so that one is bringing up a load while the other is going down empty.



A THOMSON-HOUSTON ELECTIC HOIST.

The controlling devices are at the motor end of the hoist and are all within easy and convenient reach of the operator. They consist of a rheostat lever, a lever for throwing the reversing switch, the brake lever worked by the foot, and the arm for engaging and disengaging the friction clutch. An improvement in recent machines and in the mine-hoists of the Thomson-Van Depoele Electric Mining Company places the rheostat underneath, this making the machine more competent and self-contained.

An Electric Light Company's Rules.

The electric light company operating a central station at New Berlin, N. Y., of which Mr. I. L. Richer is the manager and Mr. J. G. Holmes the president, has issued the following set of rules for the guidance of visitors at the station:

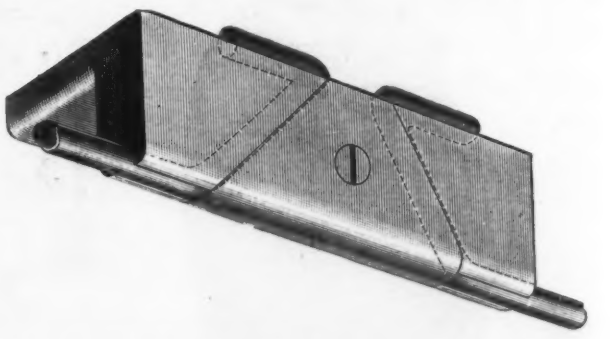


FIG. 2.—WHEELER'S TROLLEY WIRE CONECTOR.

"Visitors are welcome at any and all hours. We make the following suggestions and regulations for our mutual benefit and hope they will be respected:

"1. Ghost dances will not be allowed in the ante-room, dynamo-room or wheel-house, a space set aside for that purpose having been cleared on the ground floor of the ruins adjoining. The space can be located by having in its centre a life-like representation of the late lamented Sitting Bull, composed of an empty lime barrel in full war paint, surmounted with a cow's tail by way of plume.

"2. For obvious reasons, visitors are requested to refrain from dancing jigs on the table, teaching the chairs the highland fling or balancing on the edge of the water pail

"3. Squirting tobacco juice at a mark on the dynamo

cannot be practiced without great danger of short-circuiting the eyebolt, and thus reversing the action of the transformers, which would result in very small lights of such an intensity as to be extremely hurtful to the eyes. We therefore suggest that the attendant's hat be used as a mark, after being carefully removed from his head.

"4. All persons are warned against tampering with the wires on the back of the switchboard, as it may lead to shocking results.

"5. Young ladies having occasion to scream will, if possible, modulate their tones so as to avoid giving people up-town the impression that the company has added to its plant a steam calliope.

"6. Riding on the driving belt will not be permitted during the heavy load hours, as the unequal strain on the belt would render the lights unsteady, giving cause for complaint from consumers. No objection, however, will be offered to this amusement after 12 P. M.

"7. Ladies are requested not to feed caramels to the attendant, as we fear it would have a very demoralizing effect on his feeble intellect.

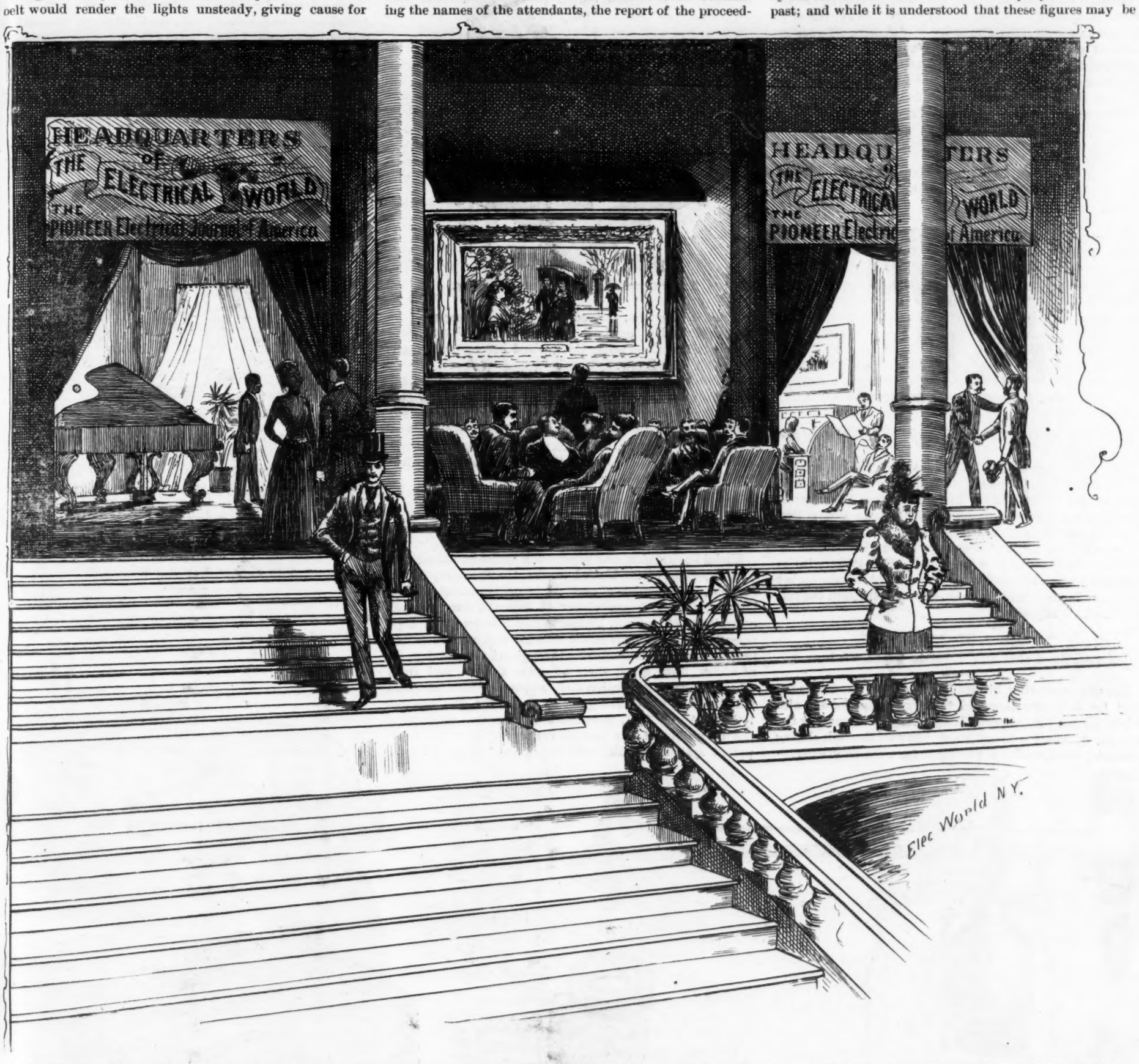
"8. Young men detained by business of the court until after 1 A. M., and not wishing to disturb the members of their household, upon application to the attendant, will be accommodated with a bed on the table in the anteroom and will be awakened by him in ample time to reach their homes before the daylight has grown strong enough to affect their eyes or open those of their neighbors.

"9. Visitors desirous of making a close inspection of the water wheel while in operation are earnestly advised to confer with Mr. F. E. Holmes before doing so. Mr. Holmes will be pleased to assist them with information and advice of great importance to their heirs.

"10. Those writing autograph verses of a personal character in the attendant's tablet are requested to sign their own names, as Mark Twain, Governor Hill and Anna Dickinson might object to seeing their names at the foot of some of the awful productions."

The Electrical World's Headquarters at the Convention.

At the recent meeting of the National Electric Light Association THE ELECTRICAL WORLD occupied the main parlor of the Narragansett Hotel as its headquarters. This parlor, at the head of the main staircase leading from the corridor of the hotel, is so large and conveniently located that it proved to be an excellent gathering place for the members who, as is always the case, spend much of their time in social intercourse. From its headquarters at the hotel THE ELECTRICAL WORLD issued its bulletins containing the names of the attendants, the report of the proceedings and other information of value to the members and exhibitors. The view shown on this page is that obtained when looking up the main staircase from the corridor, and exhibits at a glance the convenient and advantageous position which the ELECTRICAL WORLD occupied.



HEADQUARTERS OF "THE ELECTRICAL WORLD" AT THE NARRAGANSETT HOTEL DURING THE PROVIDENCE ELECTRIC LIGHT CONVENTION.

Electricity for Agriculture.

M. Camille Gonzy, the proprietor of numerous small farms in the commune of Millas (Western Pyrenees), having an area altogether of nearly 1,500 acres, has for some time past been utilizing a neighboring stream for electric lighting purposes. He has now applied electric power to the working of a wine-crushing plant. Besides providing the power for lifting and driving purposes, electricity is made to work the pumps for irrigating the vines. The 180 16 c. p. lamps employed are distributed over all the farms, and the area which they cover may be judged from the fact that the length of telephone wire connecting the buildings is 62 miles.

Efficiency of Transformers.

BY E. WILBUR RICE, JR.

I notice in THE ELECTRICAL WORLD of Feb. 21 an article on "The Efficiency of Transformers," by William Stanley, Jr., giving some data on the maximum efficiency and losses of several transformers, which transformers are said to be of the latest design of the various manufacturers.

As this comparison places the Stanley transformer at the top of the list and makes a correspondingly poor showing for the Thomson-Houston transformer, I thought your readers would be interested in obtaining some results of tests of the transformers which have been manufactured by the Thomson-Houston Electric Company for some time past; and while it is understood that these figures may be open to the objection of ex-parte statements, they are certainly no worse in that respect than the information contained in the article mentioned.

The following table, prepared by Mr. Axel Ekstrom, who has charge of this special line of work for the Thomson-Houston Company, gives some data on the transformers which are now and have for some time past been regularly manufactured by the Thomson-Houston Company:

Nominal capacity, light.	Normal output, watts.	E. M. F., primary.	E. M. F., secondary.	Ratio conversion	C²R., total.	Iron loss total.	Drop in secondary.	Maxim'm efficiency.
10	600	1,040	52	20	11.97	46.5	1	91.5
15	900	1,040	52	20	18.86	59	1.2	92.2
25	1,500	1,040	52	20	30.40	59.6	2	94.5
40	2,400	1,040	52	20	57.80	73	2	95
75	4,500	1,040	52	20	72.30	144	1.6	95.5

The method of testing these transformers is the same as that mentioned by Mr. Stanley, and the frequency is 125 periods per second.

In order that the public may have the benefit of tests which will be recognized as entirely free from the faintest suspicion of prejudice, the Thomson-Houston Company has forwarded to the Massachusetts Institute of Technology, for careful tests, a complete line of transformers taken from stock, and the results of these tests, as soon as received, will be duly published.

The Insulite Lamp Socket.

The accompanying figures show the construction of a new lamp socket that has just been brought out by the Insulite Manufacturing Company, of 35 Broadway, this city. It possesses several features of interest to those who are interested in securing a socket that has few parts, is easily and quickly wired and has a very effective "snap" at the breaking of the circuit. Fig. 1 shows the socket complete without the outside shell in position, and Fig. 2 shows the interior arrangement of the parts. The contact is a scrap-

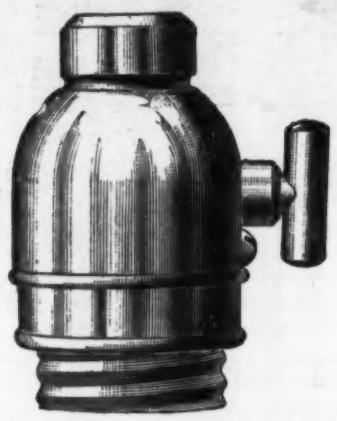


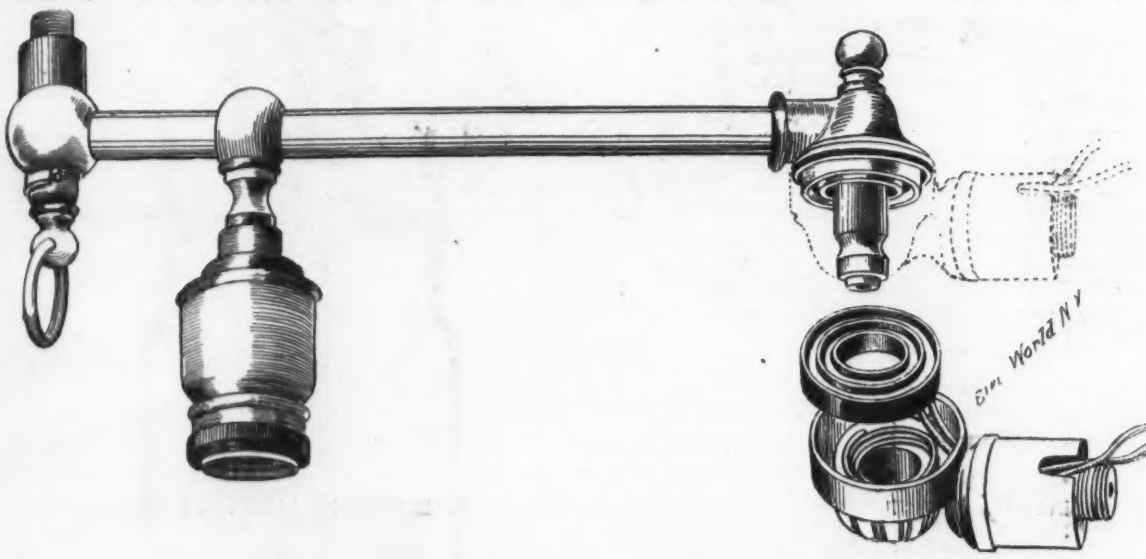
Fig. 1.—Insulite Lamp Socket.

ing one, and at every turn of the switch key is cleaned and made brighter.

The sleeve shown at *B*, Fig. 2, is a swivel which permits of the socket being screwed into position after being wired without any twisting of the lamp conductors. The process of wiring is a very simple one. The outside cap is first removed and placed over the line wire. One of the wires is inserted into the centre opening *C*, and is clamped by the set screw *D*, which is insulated. The other wire is fastened under the head of the screw *E*. After the socket is screwed to the rigid fixture a set screw through the collar *B* locks it in position.

A Combined Gas and Electric Light Fixture.

The accompanying illustration shows an ingenious design for a fixture intended to carry a gas jet and also wires for an incandescent lamp. As will be seen by the cut, the wires are not continuous, but pass through sliding contacts, which render it possible to turn the fixture carrying the lamp and gas jet around any number of times quite independent of the electric conductors. It is the invention of Mr. John Gunn, of this city. By its use many difficulties formerly experienced in carrying continuous wires over or through a fixture to the lamp itself are avoided. It will be seen that the same method of construction may be applied to fixtures carrying any number of lights.



COMBINED ELECTRIC LIGHT AND GAS FIXTURE.

The "Common Sense" Trolley Arm.

The latest improvement in trolley arms is the invention of the foreman of the Pleasant Valley electric road, and the accompanying illustration gives a clear view of the "Common Sense" trolley carrier.

The main feature is the employment of a single spring in compression instead of several springs at a tension to give the necessary pressure between the trolley wheel and the wire. As can readily be seen, the arm can be used at angles varying from two to fifty degrees on either side of the perpendicular, and the construction which admits of this point is most simple.

But the greatest advantage with this style of trolley arm is that as the pole is bent further away from the perpendicular, or say 40 degrees (the usual working angle), the upward

The "Common Sense" Trolley Arm.

pressure of the arm, instead of growing stronger as in most other trolley carriers, becomes relatively less, thus allowing of working under bridges and other places where the trolley wire is low.

The "Common Sense" trolley arm has been in successful use for several months upon the following roads: Pleasant Valley Electric Railway, Pittsburgh and Birmingham Railway, Newcastle (Pa.) Electric Railway, Washington (Pa.) Electric Railway, Braddock and Turtle Creek Electric Railway, Cumberland (Md.) Railway, and the White Electric Railway at McKeesport, Pa.

The Second Century of the American Patent System.

Under the auspices and supervision of the President and Vice-President of the United States, the Secretary of the Interior, Commissioner and Assistant Commissioner of Patents, the ex-Commissioner of Patents, congressional committees of patents, United States Senators and Representatives, prominent public officials and representative inventors and manufacturers throughout the country, all of whom have given their adhesion thereto, and from whom active participation and support are assured, there will be held in Washington, D. C., on the 8th, 9th and 10th of April, 1891, a national convention, celebrating the beginning of the second century of the American patent system. This will be an essentially national affair, and cannot fail to result in great good to inventors, manufacturers, and the whole business of the country. The objects of this convention are, among others, to organize a national association for the mutual benefit of inventors and manufacturers; to secure a proper recognition of the rights of inventors; to operate to secure the perfection of the patent system; improvement in the practice of granting patents; increasing the protection afforded inventors and the owners of patents; removing existing obstacles in the way of a more thorough administration of the Patent Bureau; obtaining a more thorough knowledge of and improving the great advantages already derived from the patent system by all the varied industries of the country. There will be three meetings held each day of the convention, presided over by the President of the United States, the Secretary of the Interior, the secretary of the Smithsonian Institution, the president of the National Board of Trade and the American Philosophical Society and other influential and prominent men, at which addresses will be delivered by men of eminence and national reputation on important topics, affording a vast fund of information hitherto generally unknown or unappreciated. As showing the character of the orators and their themes, it may be mentioned that Justice Blatchford, of the United States Supreme Court, will speak on "A Century of Patent Law;" Hon. Benjamin J. Butterworth, chairman committee House of Representatives, on "The Effect of Our Patent System on the Material Development of the United States;" Senator Daniel on "The New South as an Outgrowth of Invention and the American Patent Law;" Professor Mason on "The Birth of Invention;" the Commissioner of Patents on "The Birth and Growth of the American Patent System;" Senator Platt on "Invention and Advancement;" Hon. Edwin Willits, Assistant Secretary of Agriculture, on "The Relation of Invention to Agriculture;" Hon. Carroll D. Wright, Commissioner of Labor, on "The Relation of Invention to Labor;" Prof. Cyrus F. Brockett on "The Effect of Invention on the Progress of Electrical Science;" Octave Chanute, president of the

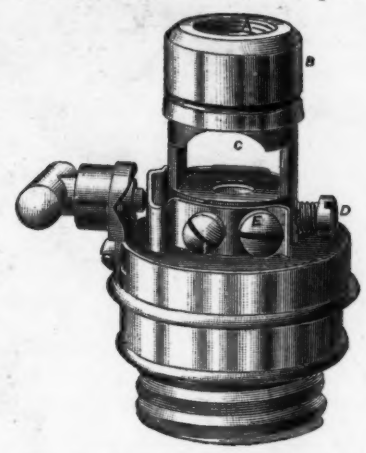


Fig. 2.—Insulite Lamp Socket.

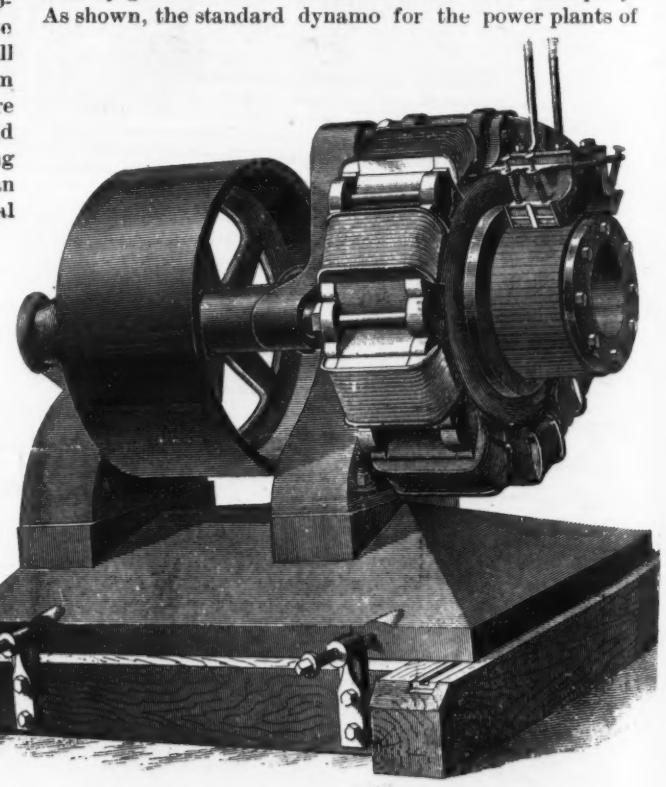
American Society of Civil Engineers, on "The Effect of Invention upon the Railroad and Other Means of Inter-Communication;" Prof. Thos. Gray on "The Telegraph and Telephone;" Hon. A. R. Spofford, Librarian United States Congress, on "The Copyright System of the United States, its Origin and Growth," and others upon equally interesting topics.

The Baxter Railway Generator.

The accompanying illustration gives a good view of the railway generator of the Baxter Electric Motor Company. As shown, the standard dynamo for the power plants of this company is of the multipolar type. It is wound for a potential of 500 volts, which is kept constant, regardless of load variations, by means of a separate exciter and the multipolar field construction, while the Gramme ring armature, of large diameter, allows of a slow speed, thus reducing to a minimum the wear on the commutator, brushes, bearings, belting and shafting.

The brush holders are so designed that the brushes are automatically fed down upon the commutator with a light and constant pressure which insures long life to the commutator and eliminates sparking due to uncertain pressure. Nothing was spared in the designing of this generator which would make it perfect in every respect, both as regards the electrical and mechanical features.

The Baxter dynamo is mounted upon very heavy bed plates, and fitted with guides and check nuts, thus avoiding all possibility of the slightest displacement under any



THE BAXTER RAILWAY GENERATOR.

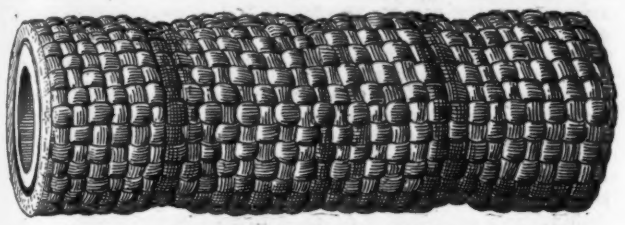
of the frequent strains to which railway generators are constantly subjected, and all vibration is prevented.

The bearings are self-oiling, and are provided with oil wells which prevent all waste of oil, and which keep the machine in a state of cleanliness. A special feature of this generator is the mounting of the pulley between the bearings, thereby relieving the machine from all torsional strain.

The Baxter dynamos are built of several different capacities from 50 h. p. up, and the illustration shows the general design of all the sizes.

A Flexible Conduit.

The glass conduit illustrated on this page is the invention of Mr. Alex. P. Wright, of the Wright Electrical

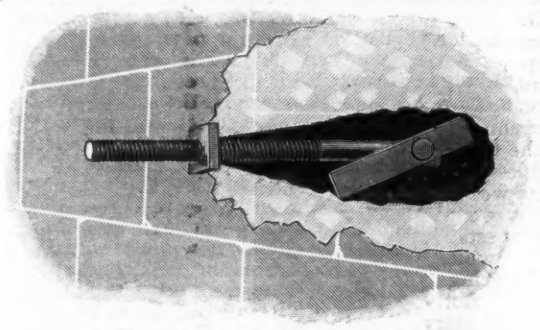


WRIGHT'S FLEXIBLE CONDUIT.

Engineering Company of Boston, and is placed upon the market by the American Circular Loom Company, of the same place. It is made of glass and it possesses the very desirable qualities of flexibility, high insulation, and tendency to resist fire. The flexible tube is inclosed in a strong woven jacket, giving it high tensile strength, and strong abrasion resistance. The whole conduit is then soaked in an insulating material, making it thoroughly waterproof. The system of connections is very simple. The cut shows a section of the conduit in its finished state, with the tube surrounded by a tough woven covering.

Toggle Bolt for Electrical Fixtures.

The accompanying cut shows an ingenious little device for overcoming certain difficulties that are met in attaching to brick or stone walls, tiles, etc. It is put on the mar-



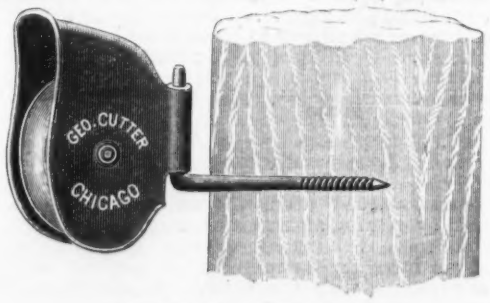
TOGGLE BOLT FOR WALL FIXTURES.

ket by the Electrical Supply Company, of Chicago. Where the obstruction is comparatively thin, as in the case of tiles or a single layer of bricks, a hole is drilled through and the bolt pushed in until the arm drops down inside at right angles to the bolt, effectually preventing its withdrawal. It is often necessary, however, to attach to a solid, thick wall, and in such cases the drilled opening is enlarged, as in the cut. The sharp corners of the arm fasten to the jagged surface of the opening, and as the nut is set the arm wedges tightly between top and bottom. The toggle bolts are made in two sizes, 3½ and 4½ inches.

The Morris Swivel Pole Pulley.

Where arc lamps are hung from a pulley over the side or centre of the street, the lamp cord usually passes over another pulley close to the pole, and then down to a cleat or windlass. This pole pulley must be in line with the cord, otherwise this will scrape along the edge of the pulley and wear out very soon.

In practice it is difficult to put up a pole pulley so as to



SWIVEL POLE PULLEY.

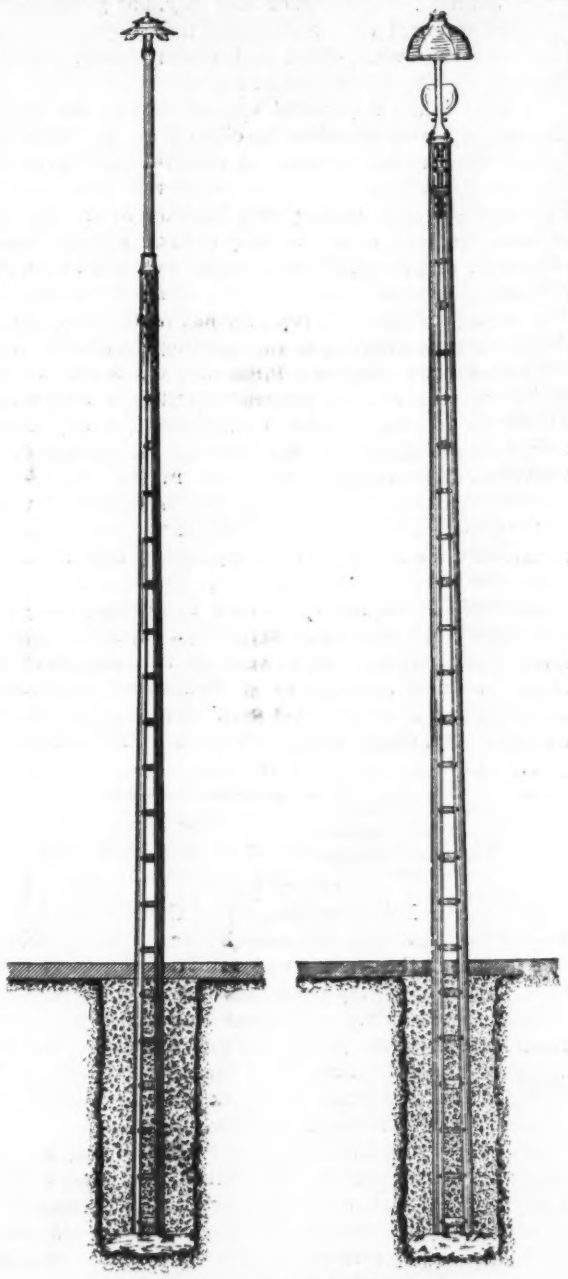
be in line with the cord, and still more difficult to keep it so. Hence the cord wears away badly and the safety of the lamp depends on its frequent renewal.

It would seem that all this annoyance and expense can be gotten around by use of a swivel pulley, such as is shown in the accompanying cut. This new sleet-proof pulley was designed by Mr. E. P. Morris, and fits the upturned end of an ordinary polestep. This is quickly driven in, and forms a firm support for the pulley, which will always swing into line.

The Morris swivel pole pulley, which will be put on the market by Geo. Cutter, of Chicago, can also be used as a wall pulley, and will be found well adapted for use in many other places where an ordinary pulley cannot be used.

A New Electric Light Pole.

We illustrate herewith a new form of pole for electric light work. This pole is manufactured by Milliken Bros., of New York, and is an outgrowth of their street railway pole, which has met with much success. These poles are constructed of two longitudinally flanged segments connected by rivets and gas-pipe separators which vary in length and thus give the pole a taper from the ground to the top. Occasionally cast-iron separators are introduced to keep the segments in line. The section of the pole shows the form of the cast-iron separator. They are very light, as the minimum amount of material for a given strength is used. The greatest diameter of the pole is at the base, where the strain is the greatest. Standard incandescent light poles are arranged for the lights to be 18 feet above the street. The pole is set in the ground 5 feet. The brackets shown are arranged for two wires, although more can be used if necessary. The top of the pole is supplied with a cast-iron reducer into which 1¼-inch gas pipe

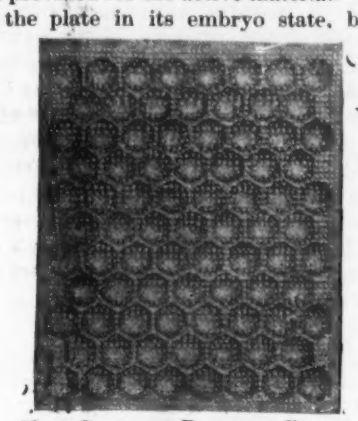


THE MILLIKEN ELECTRIC LIGHT POLE.

screws. The top of the gas pipe is threaded to receive a hood, which carries the lights. The hood is furnished by nearly all the electrical companies and can be arranged with a reflector when necessary. When these poles are used in connection with subways a hole is cored in the cast-iron separators and the wires then pass directly up through the centre of the pole. They can be protected by any of the usual forms of insulation, and cut-outs or switches can be inserted at convenient points. The arc light poles are similar in construction to the incandescent light poles just described, except that the pole proper runs to the base of the light. They can be arranged at the top to fit any special make of lamp. These poles can also be arranged for carrying the incandescent or arc lights on arms of any length. These poles have been extensively used in South American countries for ordinary forms of line work, such as telephone and electric light work. It has been found that in these warmer countries different kinds of insects attack wood and in a very short time entirely destroy the fibers, causing the pole to break short off at the surface of the ground. Parties have also found great trouble in keeping lines in operation where they pass through thinly settled districts, as the natives cut down wooden poles and use them for firewood. When furnished for line work they are supplied with an iron cross arm, on which any number of pins may be secured. These poles can be made of any length and varying thickness according to the strain put upon them.

A New Accumulator.

Many forms of accumulators have been devised since the days of Planté and Faure, some with distinctive features and some whose meritorious points existed only in the mind of the inventor; but the New Era Accumulator, which is just out, is said to possess several novel ideas, skillfully developed, which at once commend it. The distinctive features of this cell are its lightness, the freedom from all danger of buckling of the plates, and the peculiar receptacles provided for the active material. The illustration shows the plate in its embryo state, being nothing

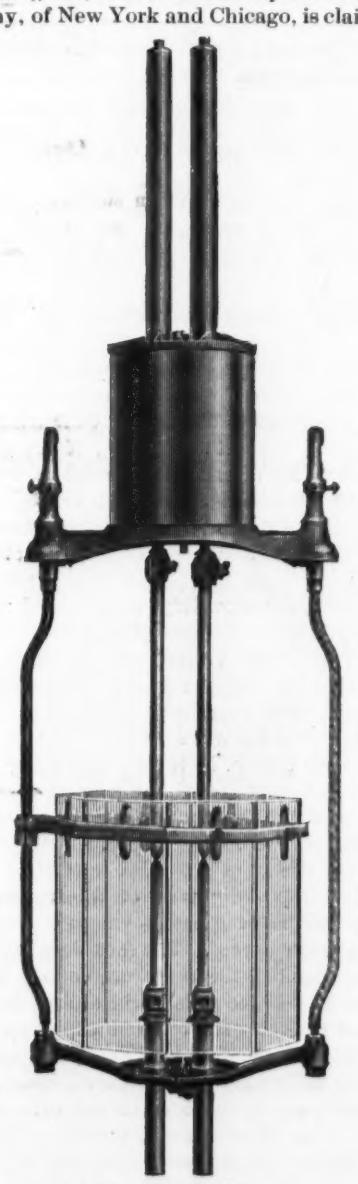


NEW STORAGE BATTERY PLATE.

more than a sheet of commercial lead, approximating one-sixteenth of an inch in thickness, punched full of small holes, which has been placed between dies which so shape it that a number of small hemispherical pockets are formed. The convex surfaces of these pockets are then flattened slightly. The pockets being filled with the active material, two plates are brought together and secured in such a manner that it is impossible for the powder to drop out, it being inclosed on all sides, yet it is open to the action of the acid through the perforations. The whole operation can be performed quickly and cheaply, as the greater part of it can be done by machinery. Plates made as described, measuring seven by eight inches, weigh but 23 ounces. The accumulator in actual service is said to have shown remarkably high efficiency and large capacity. The New Era Electric Storage Company has been formed, and will begin the manufacture of the cells at an early date.

The Gwynn Lamp Globe.

The Gwynn globe, manufactured by the Western Electric Company, of New York and Chicago, is claimed to pos-



GWYNN LAMP GLOBE.

sess many points of superiority. It consists of eight pieces of heavy plate glass bolted to a brass collar, which is fastened to the side of the lamp, as shown in the accompanying illustration. As it is open at the top and bottom, it obviates the necessity of removing the globe in order to trim the lamp, and also prevents the accumulation of any foreign matter. If a plate is broken it can be easily replaced at a very slight expense.

"A Tale of Woe."

BY H. FRANKLIN WATTS.

In view of the great progress of electrical invention, and the high value attached to American enterprise and genius, it is with great hesitation that the writer asks the indulgence of the readers of THE ELECTRICAL WORLD, while he directs their attention to what may be called the "weakest link" in the various light, power and railway systems now in extensive operation throughout the country. The writer's idea was so fully embodied in a conversation that recently took place between himself and a prominent business man, that it is believed to be worth reporting here in brief. The gentleman in question owned the controlling interest in at least two electric light plants, and was a firm believer in the high degree of perfection that electrical machinery had attained, and its consequent ability to overcome all obstacles. He had not, probably, read THE ELECTRICAL WORLD as diligently as he ought, and hence was excusable for his lack of knowledge regarding the operation of the iniquitous dynamo.

On the occasion referred to he had entered the station and engaged the writer in conversation, which shortly drifted as follows: "That's the reason these things cost so much, I s'pose—they've got so much copper in them. Where is all this copper? I don't see any." Upon being informed that the copper was covered up or "insulated," he asked further: "What is it covered up for—afraid some one will see it?"

I endeavored to explain to him that the "insulation" upon the wire was necessary to prevent contact between the different wires, which would cause "short circuits" and burn out the armature, but he interrupted me. "Do you mean to tell me that that little thin film of cloth or thread stuck on to that wire is all that prevents that armature from burning up? That armature there is worth $600." When I told him that in a modified form such was the case, his astonishment and anger knew no bounds. "If I had known that," he exclaimed, "I would have put in the Edison system."

When informed that the Edison and all other systems were the same in this respect, his disappointment was intense. "To think," he said "that the expense of all this machinery—dynamos, engines, boilers, wire, poles and fixtures—should depend upon a little piece of rag or tape that I could scrape off with a penknife. It's the most disgusting thing I ever heard of. I don't believe Mr. G. or Mr. H. knows this. I am going to tell them about it. I thought that money put into a railroad hung upon a slim thread; the flange only had to jump two inches over a steel rail to send the train down the bank into the ditch and cost the company $100,000; but this electric business is worse than that, for the stuff has only to jump one-sixteenth of an inch, or less, through a piece of cotton to knock out the whole thing, and there are millions invested in it. I thought you electricians had better sense than that. I thought you had some science, and that your machines were reliable; but this cotton-string business is the most absurd, unscientific and senseless thing I ever dreamed of."

Without continuing this "tale of woe," does it not seem that there is a great deal of truth in the statements quoted, and that the great electric enterprises are indeed hung upon a "slim thread?" The number of burned-out armatures requiring rewinding in the United States in one single year would be most astounding if the grim facts were made public. In alternating machines, for example, the heat given off from the armature is very great, and results in and is a slow process of carbonizing the cotton insulation upon the wire and rendering it a conductor of electricity.

Then, again, the crowding together of the wires in the effort to squeeze the greatest possible number of turns into a limited space, with cotton only intervening, is indeed "unscientific," to say the least. Aside from all this, to put 500 volts into a railroad motor, one side of which is grounded, and to allow water to splash upon the coils covered only with cotton, is taking too many chances. Yet just such chances are continually being taken by the various light and power companies, and then they wonder why grounds and burn-outs occur.

Again, our dynamos are more electrical than mechanical. This is especially true of alternating machines in which the field is of great power and the induction is in consequence very great. The fact does not appear to be recognized that it is the armature coils of a dynamo that absorb power. These coils in the alternating machines are laid upon a perfectly smooth and slippery core, being held in place by the band wires, and yet these coils absorb perhaps the full power of a large engine. If a first-class short circuit occurs, these coils will often stop instantly, while the core, being keyed to the shaft, still rotates until, getting wedged in the poles, the belt is thrown off. Is this method of constructing armatures and insulating them scientific or unscientific?

What is required is an insulating material capable of uniting with the coils, or rather adhering to the coils and also the iron core of the armature, holding each individual convolution of wire in place with the rigidity of iron. This material should of course be quite hard—not too brittle—and heat resisting, and should be capable of allowing the conductors that it incloses to become red hot and still continue to operate. Mr. Ferranti, in London, is using a compound of glass and sulphur, and pours it hot upon the coils, which are otherwise insulated with porcelain or mica. This insulation is in fact the secret of his ability to employ and maintain a pressure of 10,000 volts.

Let a little of the American genius now devoted to the conduit railway system be turned in the direction the writer has pointed out, and one of the greatest electrical achievements of this age will be accomplished. A ground or a burn-out would thus be not only "unlikely to occur," but *absolutely impossible* so far as the machine itself is concerned.

We want this new insulating compound to use upon the motors and generators of New York's underground electric railway. Every motor and generator should have its armature and field coils imbedded in it. Then, and then only, will the electric motor be able to compete with the steam locomotive in point of reliability on local and ex-territorial lines where the limit of speed now attained by the present locomotive has been outgrown.

Opinion of a Prominent Cable Advocate on the Overhead Electric System.

Mr. John D. Crimmins, of this city, has given his unqualified approval of the overhead trolley system as proposed for the Twenty-third and Twenty-fourth wards of New York. On this subject he says:

"I have made a personal examination of the various systems of electric motors in cities West and South. I have ridden for miles in cars of which the trolley system was the propelling power and observed the effect on all matters which would have relation to it. My conclusions are that it is the only electric system worthy of notice; that it is an improvement as great as the best elevated system over the horse cars; that it is safe and presents no objectionable features in the use of cars, and the slight objection to the poles supporting the electric wires is overbalanced many times by the cleanliness of the streets and the regularity and promptness of the service. I have no interest, directly or indirectly, in any scheme connected with the system. I favor the introduction of the system on all the surface car routes in the Twenty-third and Twenty-fourth wards, from the full confidence that I have that it will materially make the wards a desirable location for the residence of many and by that means increase the value of our properties. The systems which I have traveled over are located in Pittsburgh, Allegheny City, Chicago, Richmond, Chattanooga and Washington. I very cheerfully give my consent for a change in operating the surface railways upon avenues or streets in the Twenty-third and Twenty-fourth wards, upon which I own property, to any company organized for such a purpose."

The Meeting of the Electrical Engineers.

The regular February meeting of the American Institute of Electrical Engineers was held on Tuesday, Feb. 24. The feature of the evening was a full description from Mr. O. T. Crosby of a very remarkable series of experiments on high-speed electric traction, carried out under his superintendence at Laurel, Md., about a year ago. The work was done under the auspices of the Weems Company, and included, as is already well known, experiments with speeds as high as 120 miles an hour.

Mr. Crosby stated that the only limitation of speed was, apparently, the condition of the track. As constructed it contained severe curves, and in weight and solidity of bed was totally inadequate for the purpose intended. Nevertheless some very interesting results were obtained, especially with reference to the effect of air resistance at these extreme speeds. Contrary to what might have been supposed, the air resistance did not increase as rapidly with the velocity as had been anticipated. In the discussion that followed Dr. Dudley, who has made a special study of railroad tracks for years, thoroughly indorsed Mr. Crosby's statement that the important feature in high speed traction was solidity of track; and, further, gave some very interesting results that have been obtained on the New York Central with rails of unusual stiffness, the construction being so altered as to give increased power to resist bending strains without a corresponding increase in actual weight of rail. The results of this process have been exceedingly satisfactory, giving a very durable and smooth running track and decreasing the train resistance in a most marked manner. The reason for this appears when we consider that in passing over every joint there is a considerable flexure, and consequently an added resistance greater as the bending of the track is more pronounced. After the discussion had closed Mr. F. L. Pope exhibited one of the original models of an electric railroad made by Thomas Davenport about the year 1837. The model was in good condition, and ran perhaps as well as when, more than half a century ago, it was in the hands of the inventor. The motor did not run on the track, properly speaking, but was on the end of a pivoted arm, counterpoised at the other end by a tray containing three Grove cells, and merely trundled around on a circular rail through the action of a small driving wheel actuated by beveled gear on the motor.

Rapid Transit at the New York Electric Club.

On Thursday evening, Feb. 26, the New York Electric Club was the scene of a particularly pleasant symposium. It was, perhaps, somewhat less hilarious than those of the ancient Greeks, less surcharged with maudlin philosophy, but doubtless was quite as entertaining, and certainly more productive of practical results. After an elaborate dinner, such as the chef of the Electric Club knows well how to prepare, the subject of rapid transit for New York was given free and full discussion. Those of the audience who live on the upper part of Manhattan Island manifested a phenomenal, almost feverish, interest in the various views set forth; and well they might, for during the evening it became apparent enough that rapid transit must come. After the dinner was ended and the cigars lighted, President Madden called to order, and, after some letters of regret from invited guests, prominent among whom were Messrs. F. S. Pearson, J. W. McNamara and F. J. Monks, had been read, Mr. Heintz, of the annexed district, called up the principal question by referring to the present necessities for rapid transit in that growing part of the metropolis. Next in order came what was, perhaps, the principal paper of the evening, by Mr. F. J. Sprague, who has studied the question of rapid transit as closely, perhaps, as any engineer who could have been found. His remarks were peculiarly to the point, and the suggestions of rapid transit offered are so important as to be worthy of more than a treatment in abstract.

Mr. SPRAGUE said: For me to talk of the rapid transit situation in New York is like a young bachelor indulging in a description of the joys of matrimony. He cannot speak from the fullness of his experience; his enthusiasm will be illuminated by his hopes, encouraged by the experience of some fortunate Benedict friends, and possibly tempered by the less fortunate experience of others. But when he passes the Rubicon he does so presumably guided by his own needs and inclinations, and, if he be wise, avoiding some of the many pitfalls spread for unwary feet. There is no rapid transit in New York; it is all situation. For years we have patiently sat lean and hungry with eyes expectant and pangs increasing at a Barmecide feast, and as the guests have multiplied the scantiness of the table has become more and more apparent. Horse cars served in old delft, hackney service dressed with cobblestones, elevated railroads à la fourchette and cable roads with sauce of golden promises; all have been sent before us and we have been bidden to eat and be merry.

The formation of New York City, a city 16 miles long and with an average breadth of only 2 or 2½ miles, its northern end terminating at the boundaries of rapidly growing suburban towns and villages, and flanked at its lower end, on the one hand, by a great and prosperous city, and on the other by the terminal cities of the great Western and Southern Trunk lines, but separated from both by broad and deep rivers, bisected itself by the Harlem River, and with a population whose main travel is in one direction, make her requirements peculiarly exacting but imperatively her own. While the needs of New York and not her neighbors must determine the system which should be laid out, there is one way, and it seems to me only one, in which her needs can be well provided for and the convenience of her neighbors as well.

That New York has for a long time had urgent need of increased facilities is emphasized by the great number of projects which in the past 15 years have been brought forward and the number which is now under actual consideration. Of many of these mention is unnecessary, and time spent on them useless. They were conceived in ignorance of the city's needs, with little conception of its growth and less regard for the future. Not only this, many of them were designed when the architectural possibilities of to-day were not dreamed of for this city, when the values of real estate were undetermined, and before the great strides which have been made in the past three years in engineering construction, and the possibilities of a new form of motive power. Being so, they are antiquated and unsatisfactory.

Speaking here as a representative of the electrical engineers, I feel that we have cause to congratulate ourselves that the final adoption of any further plans have been deferred until 1891, for we have been witnesses of one of the most marvelous developments recorded in the industrial world, and can point with pride to the fact that the transmission of power by electricity has, within the past three years, taken an undeniable first place, and offers a ready solution of hitherto impossible problems. That the United States has occupied so prominent a place in this development is a source of unmixed satisfaction.

Only a few years ago you formed a hopeful band of enthusiastic pioneers, poor in pocket, struggling against cynicism and ridicule, but buoyed by belief in your work and encouraged by the bright predictions of a score of early workers who handed down the record of their work. Five years ago there were perhaps a dozen electric railways in the world. The number of motors used for other industrial purposes was small. Capitalists, car-builders, street railway officials, engineers, viewed your efforts with tolerant pity. Even we electricians only faintly realized the practical possibilities. The motor was a piece of fine and delicate machinery to be carefully housed and tenderly protected. It had hydrophobic tendencies in the presence of water and a delightful uncertainty of operation. Its construction was crude, its design unsatisfactory, its function mysterious. The vagaries of the electric current were many and surprising.

When railway work was considered, to put the delicate and erratic machine under a car, exposed to the dust and moisture, was indicative of insanity, to connect it with the wheel by gearing an insult to mechanics, and to govern two or more such machines out of sight with fixed brushes and a controlling device in the hands of an unskilled man was to juggle with the devil. To accentuate the waywardness of the current grounding one circuit and with 450 volts potential was surely flying in the face of Providence. To operate under the ordinary conditions of street service was pronounced impossible and to attempt to mount over a six per cent. grade would be to lose one's reputation. The operation of a number of cars on the multiple arc system was thought a commercial impossibility, 450 volts potential threatened unknown terrors of torture and death, the bare overhead wire promised unending conflagrations, while the rail circuit with mud, snow and ice was an electrical impossibility.

How all this is changed? Motors by the tens of thousands are singing songs of victory, and follow our will with implicit and instant obedience whether near at hand or a score of miles away. We bow before the marvelous power of electricity, but we dictate its operation.

The fear of hydrophobia has passed. The six per cent. grade has become fourteen. The difficulties of gravity have been reversed. The trouble is not how to get up but how to get down; and, here again, the electric motor by reason of its remarkable reversibility of functioning admits of possibilities denied to other forms of braking.

Boston, Cleveland, Milwaukee, Minneapolis, St. Paul and St. Louis, with all their adverse conditions of ice and snow, support the largest electric railway systems. Of all the thousands of people employed in the various duties of electric railway work, not one has ever been sacrificed by contact with the standard pressure which has been adopted for street work. Over $50,000,000 represents the investment of one class of electric motor work alone in this country.

Such has been the change wrought within the past three years. Can any observing man avoid the conclusion outlined by these facts; that the electric motor must not only be the propelling power of any rapid transit system in this city, but that that system in its entirety must be designed with special reference to its use.

So much for electricity. How should it be used? What shall be the routes over which to operate? What shall be the form of road? Shall it be elevated, surface or underground? How many tracks shall it have and what shall be the system of train service? Thanks to the electrical development and thanks also to other modern engineering advances, and especially as they have been so cleverly and intelligently put into practical operation by Mr. James Greathead, whose representative I see here, and who is better able than I to describe his methods as applied to the City and South London Electric Railway as well as other work. The answer to these questions seems to be an easy one, and it is an answer which a few years ago could not have been given.

Let us briefly review some of the proposed systems of transit and consider what is an essential in New York. Numerous propositions for years fought for have been made for replacing the horse car service by cable lines, and it has even been proposed to gridiron the city with such a system. That the cable, when properly put in, is an improvement on horse car service can freely be acknowledged; somewhat faster time can be made, heavier loads can be carried, trains can be operated in one, two or three-car units, and it is unquestionably more cleanly; but, with these acknowledged advantages, its defects are many and too well known to make it necessary to here enter into them. It is sufficient for our purposes to bear in mind the fact that it is a surface road, necessarily subject to surface limitations, and that by no possibility can it ever give rapid transit to New York City. No more conclusive proof of this is necessary than the statement that on the proposed Third avenue cable line the different sets of cables are to operate at four, six and eight, and eight miles, and the schedule speed would be about six miles an hour; but even this line, and the Broadway line as well, seem in spite of all their promises to be holding back for some reason before irrevocably committing themselves by actual construction to the great expense necessary. Is it not possible that the secret influence at work is a sudden awakening to the advances of electricity, which we all know will enable even a surface system to be run in a city street at, at least, a third safer mean speed than any other system of propulsion?

And then we have our present elevated railroad system, with its proposed changes, and viaduct roads are suggested. The latter, by reason of the limitations which largely govern the elevated railroads, independent of the serious one of great cost, need not be considered separately from the elevated system. Of the not unmixed benefits which this system has conferred upon the city of New York, I am only too glad to make admission, but it has many and some insuperable objections when considered as a possible solution of the rapid transit question, being a double track system, with frequent stops, without loop connections, subject to street grades and curves, and limited necessarily in speed. Its proposed loop connections at the Battery and Harlem River will facilitate train dispatching. It will not increase the schedule time of running; nor is any two-track railroad with the street limitations which exist in the elevated system, and with the traffic which it has got to carry, capable of giving high-speed service.

Fast time can only be had where there is freedom from bad curves and grades, where the tracks are not too crowded, and the train intervals too short, where there is a clear right of way and with distances between stops sufficiently long to allow of getting a train up to a high speed and for some time maintaining it. Already on the elevated railroads the maximum speed between stations is from two to three times the main running speed, and the duty required of engines is most excessive for their limited weight and size. Hence, four tracks are an essential, two of which should be devoted to way service and two to express service. But four tracks are certainly not not feasible in the streets of New York unless they are placed one set above the other, and that should not be considered for a moment, unless, indeed, a four-track viaduct structure should be built. In any event in such a road the express tracks would have to follow the line of way of the way tracks. Where, then, shall be put a road? Underground.

While I have been an advocate, and still am, to erect one solitary wire for an electric railway system to replace horse car service, and have thought, perhaps, that the biblical admonition, "Dust thou art, and unto dust shall return," might just as well be applied when necessary to all electricity, despite the somewhat exaggerated claims of my telephone friends, I am no believer in the so-called "God's free air" as applied to rapid transit systems in New York, because, what with our lofty buildings, and the occupancy of our streets with the elevated structures and poles of various kinds, we have no free air; but provided we go deep enough, I am a strong believer in God's freer earth, which is our common heritage; so I say again, let us go underground. But this is not all. What shall be the form of the underground construction? And where shall it run? Shall it be deep subterranean rock-blasted tunnel—because our ordinary system of blasting and tunnel construction makes us subservient to the necessity of finding a solid rock in which to work—or shall it be a form of tunnel construction which can safely pierce concealed watercourses, quicksands and clay? Shall it be a tunnel depending solely for its strength and resistance to pressure from above, and on either side of the rocky material through which it is bored? Or shall it be a tunnel providing within itself effective methods of resistance? Shall it contain one track, or two, or four? All these are important questions.

Bearing in mind the character of our soil, the accessibility of the system, the necessity of running through and along side foundations of structures without weakening them, there seems to me but one really available system for New York. Hence, I favor, in brief, four independent iron tunnels, all meeting at a common station, once every mile and a half or so, the way tunnels meeting at common stations every third of a mile, every tunnel being absolutely independent in its route except at the station, the way routes being run to accomodate the best surface intersections for existing lines of travel, and the express route, while passing beneath the way tracks at the common stations, elsewhere running in the most direct possible paths. Such a four-track system should run up the east side, thence by loops through the annexed district and at Harlem River, thence down the west side, completing a circuit by way of the Battery. This should intersect with a two-track system passing beneath the main system, with access from common stations, crossing New York on the Forty-second street line and at the Battery, and making connections with the Long Island, Broadway and Atlantic avenue stations on the Brooklyn side, and the trunk line depots on the Jersey shore. This system comprises about 135 miles of single tunnel for New York and 30 miles of tunnel in the loop, and would provide a most comprehensive system of intercommunication, the schedule running on the way service to 15 miles an hour, and on express service 30 miles. And how different such a tunnel would be from that which we have known! A rigid iron structure with all vibration deadened by the surrounding soil: an almost perfectly equable temperature; a magnificent roadbed, perfectly jointed and free from expansion and contraction; absence from dust, smoke and cinders; perfect ventilation; a structure unobtrusive in character and absolutely safe; derailment almost an impossibility: a system of braking and signaling unequaled; and a prompt and reliable high-speed service. Let us hope that we all may be prominent in accomplishing this result.

Following Mr. Sprague's remarks, Mr. C. O. Mailloux was called upon to speak of rapid transit in the National Capital. He had a tale of woe to tell of the unfortunate situation in that politician-ridden city, and said that under the conditions there existing, with overhead wires absolutely forbidden, the only refuge was in the use of storage batteries, and he had been conducting quite successful experiments with such a system. Then Mr. Louis Sterne was called upon, and responded by giving an intensely interesting account of the construction of the City & South Columbian Railway recently opened in London. Mr. Sterne was one of the engineers of the system from its inception, and gave in a pleasant, conversational way a great deal of most valuable information concerning the details of the work. His remarks, substantially, were as follows:

The common desire in all cities is rapid communication from residential to business centres, and thus to relieve the already overcrowded thoroughfares and existing means of transit as population grows in any great metropolis with commercial and industrial prosperity such as London and New York.

New York differs essentially in many particulars from other great centres of population, although the common desire to be quickly transported from place to place is universal in every city; but the configuration of New York City concentrates the pressure of the greater portion of the population, especially as the business portion is at the lower end of the city, and thus compels the movement of the larger part of its male population in opposite directions once in each day. London has always been more favored in this respect, as it has had an excellent omnibus service which has trebled in point of numbers, and has numerically increased in its transport of passengers in exact or even greater proportion. The cabs in London, with the strict enforcement of legal regulations and the low rate of fare, have also contributed largely toward the conveyance of persons from place to place. The pressure in London, therefore, is not so great, although they have made advance over New York in seeking to solve the problems of rapid transit.

Two tunnels were built in London, one by Mr. Brunel in 1860, and one by Mr. Greathead in 1868-9; the former fell into disuse until the Metropolitan Railway used it for the means of reaching the Surrey side of the river, and made its terminal at New Cross, some four miles from the mouth of the Brunel tunnel. The Tower subway, designed and built by Mr. Greathead and Mr. Barlow for omnibus traffic by gravitation, is used only for foot passengers to the extent of about 100,000 a month. The original plans were never carried out for want of funds.

The next approach to a tunnel was the well-known Metropolitan Underground, and since then the District Metropolitan, now known as the Inner and Outer Circle, a small portion of which has cost as much as at the rate of $30,000,000 per mile. These have been supplemented to a very considerable extent by the main lines of railway, both north, south, east and west of London, having their terminals as near the business centres as possible, and, with the running powers over the Metropolitan Railway, carrying an immense number of passengers from the suburban districts of London. In addition to this, we have in the city of London between 15,000 and 16,000 cabs carrying passengers at 12 cents per mile.

Street cars lines have also been laid down in the streets of London in the last 20 years, but these are not permitted to enter beyond what is technically known as the city limits. Thus their usefulness for a continuous journey across or through the metropolis has been minimized.

Many attempts have been made by the Metropolitan and the District Railway, and also by private corporations, as promoters, for increased facilities in London, but the moment they showed on the walls of the committee rooms, either in the House of Commons or in the House of Lords, the old system of disturbing streets and vested rights and properties, with the old method of traction involving asphyxiating air, brick porous lining, and the smoke and gases of the engine, the bills were thrown out and never came beyond the first committee.

Subway work ceased, until cable traction suggested to Mr. Greathead the possibility of making his system of deep tunneling successful for rapid transit. Mr. Greathead's name is now as well known in Great Britain and is as closely associated with deep tunneling as the name of Mr. Edison is associated with electricity. Although the cable suggested the possible traction in deep tunnels, electricity solved this problem for Mr. Greathead, as neither safety nor speed in cable traction can compare with that of electricity, and the iron lined and cemented tunnel lends itself perfectly to electric traction.

The American people will not be slow in adopting the improvement thus developed in Great Britain, and which will make underground means of transit as safe and as healthful as the surface roads have been until now; and will also make these substructures in all cities in the United States as important an element as the elevators have proved in utilizing the upper streets, and practically doubling the area of the densely populated districts of every great city in the United States. You have not lost much time in adopting these improvements in the mode of rapid transit underground, and you probably have profited by waiting until the advance came to you from Great Britain. Just as you have benefited by postponing the building of a United States navy and naval armaments, you have now been enabled to take advantage of all that has been done, and adopted the best design of the many cruisers which formed the experimental period preceding the rebuilding of your navy, and thus saved many millions of dollars and much vexation; and it may not be long before Great Britain will have to look to the United States for the adoption of many improvements made here.

You are fortunate in having such an earnest and able commission appointed by your chief magistrate—an appointment confirmed by the State, and with full powers to give the necessary facilities for rapid transit in New York, and for New Yorkers especially.

Mr. T. Graham Gribble, of London, spoke specially on the engineering difficulties that will have to be encountered in work in New York, and gave an interesting account of the duplex railway system, the adoption of which as a means of solving the rapid transit problem he had recently advocated before the Rapid Transit Commissioners. After brief remarks from Mr. W. J. Richardson, secretary of the American Street Railway Association, who is a firm believer in electric rapid transit as seen from the point of view of a practical street railway man, Mr. Charles E. Emery said: "Speaking of the plan which seemed to be the best adapted for rapid transit in New York, we meet the necessity of having four tracks on the main line, one on each side of the city.

"Unfortunately, gentlemen, you have all to use steam engines as yet. We therefore consider that steam is a necessity of the case, but that on account of the losses in small steam motors, on account of the gases which accumulate in the tunnels, the electric motor has solved the difficulty of running through places where steam cannot go. Therefore, while I quite agree with all here present as to the value of this system, it takes its place only as one of the many means which we have at our command to solve the greater and broader problem."

After a few remarks from Mr. H. H. Neill of the *Commercial Advertiser* on the relation of the press to rapid transit, and the present state of public feeling on the subject, Mr. Edward Weston was called, and gave the following interesting account of some of the engineering difficulties that have to be met, and the possible means of surmounting them. As will be seen from his remarks, Mr. Weston was thoroughly confident of the practicability of a tunnel system such as seems to be needed, provided the one question of finance were properly settled.

Mr. EDWARD WESTON said: Mr. President and members of the club, I shall not attack the problem of rapid transit from what I should strictly call the point of view of engineering difficulties as separated from the electrical difficulties connected with it. I take it for granted that the engineering difficulties can readily be surmounted; that they are not very serious in character outside of the question of cost. Many years ago Brunel designed and constructed the "Great Eastern." You know how much trouble that steamship gave the company which was organized for building it. Considerable litigation sprang up in consequence of those difficulties, and during some of the litigation Brunel was put upon the witness stand and was considerably annoyed by the questioning of the counsel on the opposite side who twitted him upon his failure to successfully launch the ship without wrecking the company. One of the lawyers who was somewhat brighter, apparently, than the rest, asked Mr. Brunel some very sharp questions in regard to the "Great Eastern," and not getting very satisfactory replies he said to Mr. Brunel, "I suppose you would not have any hesitation about building a tunnel from here to China." Brunel instantly replied, "No, sir; I would not hesitate about it one moment if you would not hesitate about raising the money to carry it through."

In reality that was the much more difficult problem. That is largely the question in respect to rapid transit. We are located in a city where property values are very high. We must acquire the right of way for the passage of our trains for the accommodation of the public at large. Having acquired the right of way the problem falls either upon the mechanical engineer who would take up entirely the old mechanical means of transmission, or upon him and upon the electrical engineer. In the latter case the responsibilities would be divided, the mechanical engineer taking care of what may be said to be the mechanical part of the business, and the electrical engineer the electrical part. I shall dismiss the mechanical engineering branch, conceding that that can readily be overcome, and consider only the electrical engineering difficulties in the way.

Mr. Emery has said that for the general purposes of carrying of passengers long distances steam takes the lead. It does to-day unquestionably. Does it necessarily follow that it should take the lead because at the present moment we have to depend upon steam for the generation of the energy that we require to propel our electric vehicles? I do not think so. I think that is a very grave mistake. The steam engine is an exceedingly inefficient means of transforming the energy to be derived from the coal into available power or for doing useful work. Therein our hands are tied to a large extent.

When it is considered that the best of our steam engines to-day do not yield us over about 20 per cent. of the actual energy of the coal, you can appreciate the unfortunate position of electrical engineers. Looking at the other side of the problem, how much that impresses itself upon us who have given steady attention to it is very remarkable indeed. The dynamo can be made to-day to yield 98 or 99 per cent. of the energy expended upon driving it in actual electrical energy. Of that, 94 or 95 per cent. can, under proper design, be again utilized in the form of electrical energy. If we are not able to attain these results it is because we do not carefully study the problem.

In the locomotive we have to deal with a very different problem from what we have to deal with in the electric motor. In the electric motor the efficiency does not decrease very perceptibly with a reasonable decrease in size

of the motor. In the steam engine, on the other hand, it does decrease with a reasonable decrease in size. Small electric motors can be made of nearly the same efficiency as larger ones. Now such being the case, small motors applied to the axles, or with their power transmitted to the axles of the cars in such a manner as to eliminate all loss between the motor and the cars, will yield vastly greater results and better results than a single steam engine located at the head of the train. I think Mr. Sprague some years ago considered that question and pointed out the vast superiority of the electric system in efficiency as compared with the steam system when it was taken into consideration that each car had its unit motor and that the tractive force of the whole train was distributed in about the proportion of the actual load on the respective parts of the train. The tractive force in the case of a steam locomotive must all be put in the locomotive. We all know how many tons have to be put on a locomotive in order to get that tractive force, and how far that may be reduced, and how far the efficiency of the electric system may be made to exceed in general that of the steam system will be better understood after more thorough experimentation and study than has been given to it so far. It does not follow by any means that we must have a less efficiency by the intervention of an electric motor. On the contrary, it may be proved, and I think will be proved, that the electrical system will be more efficient than the steam system as generally employed.

In considering the question of what is the best means of rapid transit for a city like New York, we have a number of problems to deal with outside of the question of first efficiency or economy. There must be convenience, quickness of stopping and starting, and every one will concede that the lighter the parts that are to be moved the quicker we can stop and the quicker we can start, the less wear and tear, the less strain on our apparatus and generator. Consequently, the electrical system there should possess an enormous advantage over any steam system by reason of the very fact that from the lighter loads and the lighter weights you have to carry in proportion to the power developed you could stop and start quicker without injury to the machinery. Then again, in the electric motor we have something entirely different from what we have in the steam engine. We have no reciprocating parts, but continuous rotary motion. The strains are all tangential, and that ought to aid greatly in running and maintenance. The electric motor of to-day is not what the electric motor of a few years hence will be. To-day we are struggling with difficulties connected with the commutator end of the line, which has been the great bugbear of all systems of electric railroads. Commutators and brushes require more care, outside of gearing, than anything else we have to deal with. They are the weakest spot in the motor, and they are the weakest spot in the dynamo. The question arises, Can those difficulties be overcome? I think they can. But if they are not overcome, are they not sufficiently overcome to warrant our placing our reliance upon such a system of transmission?

The ideal electric motor for the transmission of power would be a motor running at a continuous and uniform speed and with a variable gearing, giving the motor the advantage of power when the car was first started.

As to what can be done here in regard to rapid transit, or anywhere else, under conditions most favorable to it, where the question of first cost in the first plant is sacrificed, I take it for granted that none of us know. It can only be found out by actual test. There is no question about that. That the return will far exceed our most sanguine expectations in that direction I am sure. With skill, ingenuity and care, there is no question in my mind about the development of rapid transit in this city or any other by means of electricity.

It has been remarked that we have nothing by which we can supplant the steam engine. Well, if we have not, we shall have it. A few years ago we had not a telephone, but there were people who believed in the possibilities of it, and it has come, and just as sure as you live we shall discover a means of getting rid of this confounded steam engine. It is a nuisance. It requires an immense amount of care, and it is an expensive apparatus to run and very unsatisfactory. Forty years ago, I think, the first experiments were made in connection with getting electrical energy direct from carbon; that is, from the combustion of coal, if you choose to put it so. They were successful so far as they went. They were much more successful than many of the efforts that were made up to within a few years in regard to the transmission of speech. The principle is there. It needs to be followed up.

I remember when I was a boy making some experiments in that line my attention was first drawn to it by an experiment described in a little book on scientific subjects, written by a somewhat famous man, Professor Pepper, called the "Play Book of Metals." In that book was first described, so far as I now remember, an experiment in which electrical energy was directly obtained from the oxidation of carbon. The experiment consisted simply in taking a little common saltpetre or nitrate of potash, fusing it in an iron pan, and placing in the iron pan, but not in contact with it, a piece of charcoal or carbon. That piece of charcoal was held in position by a platinum wire, and that formed one pole of the battery, while the iron formed the other pole. Under those circumstances the carbon was much more rapidly oxidized than the iron, and as a result of it an electric current was produced. About ten or fifteen years ago that experiment was revived and announced as a grand discovery. Now, since it has been proved that carbon can be oxidized in that manner, and that carbon can be oxidized also without the application of heat, it does not seem to require very much to carry us further along to producing the thing itself. Whatever is done in that direction will come right into play in connection with the future rapid transit system of New York and the world.

During the evening one of the model electric railways constructed 55 years ago by Thomas Davenport was shown in operation, and its slow rotation formed a striking contrast to the electrical rapid transit in which the audience have expressed so firm a belief. The general concensus of opinion was undoubtedly in favor of an underground railroad as the only solution of the enormous difficulties that are to be met in New York, and the Greathead system indorsed indirectly by Mr. Sprague, and so ably expounded by Mr. Sterne, was looked upon with great favor. After a long and pleasant meeting the assembly broke up and plodded their respective ways homeward through the snow, breathing fervent prayers for rapid transit and imprecations against the difficulties that have stood in its way up to the present.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The adjournment of Congress this week is looked upon by all interested in financial matters with great relief The amount of trouble that this Congress has caused in the financial world has been far beyond ordinary.

The unsettling of business was caused by the passage of the Tariff Bill, and the overhanging shadow which has remained continually in the prospect of silver legislation has given no end of apprehension. Bankers have been frightened out of their wits and are afraid to loan money. Investors have been slow to invest money, because they know not of the possible trend of legislation.

Legislators with personal interests first in view and with no regard for any one else save the pleasing of their own constituency have offered enough trash in the way of financial legislation during the present Congress to undo the nation's credit and upset our whole financial system, if their bills offered had been passed.

A Rising Market Expected.—It is confidently expected now that the market for stocks and, in fact, all speculative business will make an upward movement.

The bank statement showed a decrease of $2,136,600 in deposits. The decrease however, means that the money from the New York banks is moving westward. Money accumulated in New York on account of a lack of confidence on the part of investors to invest during the financial troubles. General business now, however, seems to be in a fairly satisfactory state and money is finding its ordinary channels.

The market for the week has been inclined to dullness. On the New York Stock Exchange the changes were very slight and were confined to a few stocks. Taking a list of active stocks for the month of February it is a noticeable fact that the greatest increase of any one stock for the month closing with Saturday was Edison General Electric, which made an increase of $13 per share. That looks very well for electric stocks and ought to recommend them to the consideration of conservative investors.

Edison stock closed Saturday night 104½ bid. It has not been particularly active during the week, but remains remarkably steady.

Boston Electric Stocks.—The transactions on the Boston Stock Exchange in electrical stocks are fewer than are generally seen. A good deal of stock has nevertheless been sold. Now is a good time to buy stock. The market is not particularly strong, and stocks are to be had cheap. A good many people make the mistake when they deal in stocks of following a leader, and that leader is usually the drift of public opinion and the tendency of the market. It is not always well to follow such a lead. If you are selling and everybody else does the same, you are going to find a very poor market to sell. Make up your mind what you want, and being strong in the conviction you are right follow your own inclination, and the chances for your success are greater than they would be otherwise. Generally it is well to buy on a selling market and sell on a buying market, unless some special information makes you strong in the conviction to the contrary.

Westinghouse has been steady during the week. The public seems to be thoroughly aware of the successfu outcome of the Westinghouse Company from its financial difficulties, and has faith in the common stock of the company.

Fort Wayne Electric Stock has been having an active market for the last month and at increased prices. On the basis of its business the stock is a good purchase.

American Bell Telephone Stock has been selling to an active market during the past week, and has increased at the rate of almost a point a day since last Tuesday. American Bell rights are also in active demand at about 18. Counting the rights at that figure and adding to the present price of Bell telephone would make the stock stand at 211. The prospect of the expiration of the patent certainly does not seem to affect this stock yet.

Chesapeake and Potomac Telephone Stock gained six points on Tuesday last, going from 50 to 56. F. Z. M.

F. Z. Maguire & Co., electrical securities, 18 Wall street, send closing quotations of electric stocks Friday, Feb. 28, 1891, in New York, Boston and Washington:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	81¼	81¾
American Telegraph & Cable	100	14,000,000	83	85
Central and South American	100	5,000,000	145	160
Mexican	100	2,000,000	210	220
Commercial Cable Co	100	7,716,000	105	109
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	15,000,000	105	106
Consolidated Electric Light	100	1,922 400	....	....
" " deferred	100	2,496,500	....	....
Edison Electric Illuminating Co	100	2,567,800	79	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	44¾	45¼
" " preferred	25	4,000,000	25⅛	25⅞
" " Series C	10	400,000	12	13
" " Series D	10	120,000	6¾	7
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1 000,000	....	....
" European Welding Co	100	1,000,000	60	....
Ft. Wayne Electric Co.	25	4,000 000	12½	13
Westinghouse Electric Mfg. Co	50	5,000,000	11⅝	11⅞
Telephone:				
American Bell	100	12.500,000	194	194½
" " rights			17¾	17⅞
Erie	100	4,800,000	47⅛	48
New England	100	10,504,600	50⅛	....
Mexican	10	1.280,000	65c.	....
Tropical American	10	400,000	....	1
Edison Phonograph Doll	10	1,000,000	....	1
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	....
Chesapeake & Potomac	100	2,650,000	57	65
American Graphophone	10	600,000	7¼	9
United States Electric Light (Washington)	100	300,000	152	165
Eckington and Soldiers' Home Electric Ry	50	352,000	58½	61
Georgetown and Tennallytown	50	200,000	60	63¼

* Ex dividend.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$230@$245	Cumberland	$60@ $62
Central Union	57@ 58	Wisconsin	118@ 120
Michigan	87@ 89	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell	40@ 43		
ELECTRIC LIGHT STOCKS.			
Chicago Arc Light and Power	$94@$96	Chicago Edison	$140@$150

AFFAIRS OF THE COMPANIES.

The Akron (O.) Electrical Company.—Stockholders of the Akron Electrical Manufacturing Company held their business meeting last week in the company's office. F. A. Wilcox, W. D. Chapman, E. B. Miller, John McGregor and W. B. Doyle were chosen directors of the new concern. The directors elected the following officers of the company: President, F. A. Wilcox; vice-president, E. B. Miller; general manager, W. D. Chapman; secretary and treasurer, W. B. Doyle. The company starts out with a capital stock of $100,000 and will locate its works in the South End. The company will give employment to 75 men and will manufacture the Loomis patents and genera' electrical supplies.

The American Bell Company makes the following statement of the output of telephones for the month ended Feb. 20 and for the fiscal year to date, with the following comparisons:

February.	1891.	1890.	
Total output	6,072	4,298	Inc. 1,774
Returned	3,276	2,261	Inc. 1,015
Net output	2,796	2,037	Inc. 759
Dec. 21 to Feb. 20.			
Total output	10,237	7,640	Inc. 2,597
Returned	6,394	4,502	Inc. 1,892
Net output	3.843	3,138	Inc. 705

The Bell Telephone Company now has 481,938 instruments under rental, which compares with 447,999 telephones at this time last year, an increase of 36,940 instruments

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, March 2, 1891.

Mr. E. L. Clarke, secretary of the Illinois Electric Material Company, visited friends in Boston and New York during the past ten days, and placed a number of orders for electric specialties for his Western trade.

Mr. R. S. Brown, Westinghouse railway representative for New England, has closed a contract for his company with the Biddeford & Saco Street Railway Company. The road is to be running May 20th. The United States Railway Company will do the construction line work.

American Institute of Electrical Engineers.—The following persons were elected to associate membership at the meeting of the council February 24: Watson G. Anthony, assistant electrician, The Okonite Company, 32½ Webster street, Newark, N. J.; Reginald Gordon, assistant in physics, Columbia College, New York City; Louis H. Landy, assistant in applied chemistry, School of Mines, Columbia College, New York City.

Mr. F. W. Best, of the firm of F. W. Best & Co., dealers in combination and electrical fixtures, Denver, Colo., is one of the welcome visitors in New York this week. Mr. Best reports that there is a greater proportion of incandescent lighting among the residences in Denver than in any other city in the United States, and that some of the most artistic electroliers manufactured by his company have been placed in new residences in Denver.

The Electric Railway Specialty Company has established temporary offices at 50 Broadway, New York, until the company's permanent offices in the new building at 29 Broadway are ready. Mr. J. F. Porter, formerly president and general manager of the Central Electric Construction Company and Southern Electric Supply Company, of St. Louis, organizer of the St. Louis Supply Company, and lately with the Edison General Electric Company, will manage the company. Mr. C. J. Mayer, formerly with R. D. Nuttall & Co., of Allegheny, Pa., will act as general traveling agent. The company will furnish all necessary supplies for street railways, including track material, car equipment, wooden and metal gears, fixtures and trolley wires, positive connection joints, spring clip cut-outs and a new style of tree insulator which is simple and efficient.

The New York Electrical Society.—The next lecture before this society will be given at Columbia College School of Mines on the evening of Friday, March 6, by Charles E. Emery, Ph.D., the well-known engineer, on the subject of "The Utilization of the Forces of Nature." This lecture will be remarkably well adapted to interest both a popular and technical audience. Starting with a brief classification of the various known forces, the speaker will refer to the various familiar phenomena which produce currents of air and of water; to the storage of energy in fuel, due to the action of natural forces in former ages; illustrate on the screen a tornado, a lightning flash and the effects of winds and storms on trees and buildings; show various views of windmills, including examples of those used for draining the Holland polders, contrasted with those of American construction, and describe briefly the principles of regulation of various windmills. The subject of water power will be treated exhaustively, with illustrations of different kinds of water wheels, notes as to the relative efficiencies, an explanation of the turbine, interspersed with views of waterfalls, glaciers, and references to important works and means employed to transmit the forces and utilize them at a distance. The methods of utilizing the energy stored up in fuel will be illustrated by several examples of land and marine steam engines and of steamers of the merchant and naval marine. It is proposed to curtail the remarks in relation to the application of electricity as being already familiar to the audience, and instead thereof to discuss the relative efficiencies of the different means available for utilizing the energy of natural forces and show the applicability of each for particular purposes. The evening, in short, promises to be one of the most useful and interesting ever enjoyed by the society. L. H. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Feb. 28, 1891.

Mr. A. E. Bliss, manager of the Malden Electric Company, is dangerously ill of fever at his home in Malden, Mass.

Mr. Sherman L. Whipple has been elected treasurer of the Redding Electric Company, vice Harvey Redding, resigned.

Mr. Maybin W. Brown, president of the Eastern Electric Supply and Construction Company, is contemplating a visit to Cuba early in March.

Biddeford, Me.—Representatives of three electric companies were at Biddeford last week making propositions to equip the Biddeford & Saco Street Railway with electricity. It has not yet been decided what system will be used.

Mr. Louis R. Wallis, formerly with the Bernstein Electric Company, has been appointed New England agent of The Buckeye Electric Company, of Cleveland, O., manufacturers of incandescent

lamps and appliances. Mr. Wallis has handsome offices at 85 Water street, Boston.

The New England Port-Electric Company, which has been making experiments on a track at Harvard street, Dorchester, has demonstrated the fact that it is entirely practicable to run cars suitable for carrying mail or express matter at the rate of two miles a minute with perfect ease and safety, and plans are nearly perfected for building a practical line for business purposes.

Worcester (Mass.) Exhibition Opened.—The Industrial and Mechanical Exhibition opened last week. Ex-Congressman W. W. Rice presided. The following gentlemen spoke: Ex-Mayor Clark Jilson, A. S. Roe, W. H. Bartlett, Eben F. Thompson and Mayor F. A. Harrington. The Mayor pressed the button and set in motion the electric motors which run the machinery of the exhibition. The exhibits were in position, with the exception of some delayed electrical apparatus. There was a large display of merchandise and other industrial products. The exhibition will continue until April 1.

Prof. Elihu Thomson delivered a very interesting address upon "The Thunderstorm from the Standpoint of Modern Science' before a large audience at Town Hall, Swampscott, Mass., last week. The lecture was illustrated by experiments that were made successful in spite of the dampness of the evening, by the ingenuity of the lecturer. He produced most of the effects of thunder, lightning, brush discharges and the aurora borealis and spoke at some length on the researches recently made by Professor Crookes, of England on the effects of discharges in vacuo. The lecture was enjoyed very much by the audience, the more so as it was the first appearance of Professor Thomson before his townspeople.

Lecture on Thomson Slow-Speed Motor.—At the last meeting of the Harvard Electric Club, of Cambridge, Mass., the members enjoyed a very interesting lecture by Lieut. Cahoon, of the Thomson-Houston Company, on the new slow speed car motor of that company. The motor was described in detail and several photographs shown. A number of interesting facts were given which showed the skill and care with which the various parts have been designed. A car with the new motor was loaded with three tons of gravel and started up a grade of 13 per cent. on a curve of about 50 feet in radius. The ampères ran up to 146, but the motor stood it, and tugged the car up successfully. Comparisons between the new and old types show that the single-reduction geared motor requires 10 per cent. less current for a given work. Its efficiency is about .84 commercial and .89 electrical. C. A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Feb. 28, 1891.

Mr. A. C. Gibson, of the Gibson Gas Fixture Works, returned last week from a three months' trip through England and other parts of Europe.

Mr. H. A. Rogers, of the *Electrical Northwest*, St. Paul, Minn., has been stopping in the city a few days looking after the interests of that paper.

Mr. R. L. Cohen, of Camden, just completed installing a 30 incandescent light plant for the Philadelphia Vinegar Company, of South Front street, using a Cohen slow-speed dynamo.

The Ball Engine Company sold last week through its Philadelphia agent, Mr. J. W. Parker, a 140 h. p. engine and an 80 h. p. boiler to the Langhorne (Pa.) Electric Light Company.

Mr. M. S. Shapleigh, of 112 South Fourth street, has accepted the agency for Philadelphia and vicinity for the Connecticut motor manufactured by the Connecticut Motor Company, of Plantsville, Conn.

Messrs. W. S. Griffith & Co. have contracted with the Tarpon Springs (Fla.) Irrigation and Developing Company for a 1,000 incandescent light plant, which will illuminate the streets of that town.

The Lock Haven Electric Company, installed by Mr. C. M. Blanchard, of this city, is now on a paying basis, with 1,250 lamps contracted for, and the prospect of increasing the capacity to double what it is now.

Mr. G. A. Wilbur, Philadelphia manager for the Fort Wayne Electric Company, has leased the entire first floor of the building at 907 Filbert street, and is making extensive improvements. The front part is being divided into general and private offices, and in the rear will be kept a full line of electrical supplies, such as are used in connection with the Slattery incandescent and the Wood arc light systems. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Feb. 28, 1891.

Prof. Barrett, city electrician of Chicago and chief electrician of the World's Fair, was in St. Louis last week.

Transportation Plan for the World's Columbian Exposition.—The anxiety on the part of the World's Fair directory to provide adequate transportation facilities for Jackson Park promises to introduce a new electric elevated railway system in Chicago. A representative of the Adams electric elevated railway system has been before Chief of Construction Burnham with designs for the road which, he argued, would be admirably adapted for intramural transit in the park, as well as for carrying passengers to the site. The Adams company, which controls the patents of the new railway, claims to be a construction company only. It is said that the Adams company would be given the right to operate its road on the grounds without paying for the privilege if it should be able to construct its line from the centre of the city. The Adams system is unlike most others in the country, using a single-track, the rail being on posts at intervals of 40 feet. The cars are propelled by electricity, and are so constructed that the centre of gravity is below the track. In other words, the car straddles the track. A compartment running lengthwise through the middle of the car contains the two large front and rear wheels. In the middle of the car, too, is the electric motor which furnishes the propelling power. Underneath the coach are guide wheels, front and rear, which keep it from tipping to either side. Each car will hold 30 passengers, the entrance being from the rear. The front platform will accommodate five more, providing they wish to stand up. No more than 30 passengers will be carried inside the coach, the idea being to give each a seat. The projectors of the road claim that its cars can be run at the rate of 25 miles per hour, and that they can be stopped within a distance of 100 feet. It is intended that no trains shall be run, but that each car shall have its own motor and thus be easily started and stopped. Being elevated on posts, it is claimed that the track could be run along the sides of the street near the curb. The cars are 10½ feet wide, so that but a few feet of the car would project over the sidewalk. It is further claimed that the machinery is so constructed that, with the use of leather, the sound of the moving car is so deadened as to make it practically noiseless. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., Feb. 28, 1891.

Jacksonville, Ga.—It is stated that there are several new companies preparing to apply for charters for the purpose of establishing electric lines.

Columbia, S. C.—The Columbia Street Railway Company has decided to change its line to an electric system, and will extend the road to various suburbs.

Attala, Ala.—The city will issue $50,000 of bonds for the construction of an electric light plant and the establishment of other municipal improvements.

Jacksonville, Fla.—The Jacksonville Street Railway Company has petitioned the city council for the privilege of changing its lines to an electric system.

Wytheville, Va.—A franchise has been issued to George L. Colgate, for the construction of an electric railway. The Thomson-Houston system is to be used.

Troy, Ala.—A movement is being made looking to the organization of a company to establish an electric light plant. The city has contracted for its erection.

Galveston, Texas.—Twenty miles of electric street railway are now in operation. Next summer the city's traction will be extended to over fifty miles of road.

Woodbury, Md.—The Woodbury and Belt Electric Light and Power Company has been organized, with a capital stock of $100,000. J. E. Hooper is president of the company.

Bentonville, Va.—The Bentonville Mining and Improvement Company contemplates the erection of an electric light plant and is now preparing estimates of the cost of the same.

Athens, Ga.—Work is progressing satisfactorily on the new electric car line, and will be completed within a few days. The contract for erecting the dynamos has been awarded to L. L. Stevens.

Lynchburg, Va.—The new electric line will be in operation during the next month. The trolley wire has been strung along Main street and almost all of the track on the line of the city has been laid.

Norfolk, Va.—The Norfolk and Eastern Development Company, of which M. Unstadter is president, is negotiating for the building of an electric line extending through its property, which lies adjacent to Norfolk.

Charlotte, N. C.—The Board of Aldermen is petitioning for legislation which will permit a popular vote on issuing $200,000 of bonds for the purpose of enabling the city to own its electric light plant and water-works.

Columbia, S. C.—The Telegraphers' Association has been formed among the students of the South Carolina University. The young men have a line erected which makes a circuit of the campus and affords beneficial practice.

Oxford, Ala.—Oxford Lake Line will hold a stockholders' meeting on the 9th of this month, to consider the question of increasing the capital stock to $175,000 to provide funds for the equipment of the road as an electric system.

South Pittsburgh, Tenn.—The annual meeting of the stockholders of the South Pittsburgh electric light and power company will be held on the 17th inst. for the election of directors and such other business as may be before the meeting.

Hendersonville, N. C.—A bill has been introduced in the North Carolina Legislature incorporating the Hendersonville and Brevard Telegraph and Telephone Company to construct and operate a telephone line between the points named.

Mr. A. H. Leftwich, of Spartansburg, S. C., and Mr. W. A. Stadelman, of Philadelphia, are negotiating for the Bristol (Tenn. and Va.) street railways. They have options on both roads, and will, no doubt, close the contract in a few days.

Vicksburg, Miss.—The Postal Telegraph and Cable Company has instituted proceedings of condemnation for right of way from Vicksburg to New Orleans, and this company will soon have a main line from Memphis to New Orleans along the Valley Railroad.

Columbia, S. C.—The Columbia Electric Power and Suburban Railroad Company, recently incorporated, has been organized by the election of J. Q. Marshall as president and J. S. Verner as secretary. Preparations are being made to commence work immediately.

Richmond, Va.—The electric light committee of the city council made a report recently recommending the rejection of the ordinance allowing the Traylor Electric Company to erect poles and wires for the purpose of furnishing electric lights to private consumers.

West Point, Ga.—The West Point Manufacturing Company is constructing a telephone line from the office in its bank building to its cotton mills in the suburbs of the town. It has its mill lighted by electric lights and is contemplating establishing a plant for the benefit of the city.

An Ocean Cable.—At a meeting of the Cotton Exchange of Norfolk, Va., resolutions were adopted memorializing the president and board of directors of the Western Union Telegraph Company in regard to the establishment of an ocean cable between Norfolk and New York City. V. N. B.

ENGLISH NOTES.

From our own Correspondent.

LONDON, Feb. 11, 1891.

The Patent Office.—Attention has been called in the House of Commons to the enormous annual surplus of the Patent Office, which now amounts to close upon £100,000, and it was suggested that the renewal fees for patents should be considerably reduced. The Chancellor of the Exchequer's reply to this was that he thought heavy renewal fees beneficial rather than otherwise, inasmuch as they tended to eliminate worthless patents, and that large sums were about to be expended in the construction of a new patent office and in placing increased facilities at the disposal of the patenting public.

Electric Lighting Enterprise.—A parliamentary report, just issued by the Board of Trade, contains one or two facts which may be of interest on your side of the Atlantic. The combination of the gas and electric lighting business, for instance, which seems to meet with considerable vogue with you, is at discount with us. Out of 13 gas bills only one proposes to combine the two undertakings. Tramway construction again seems still on the decline, parliamentary powers being sought for only 24 miles of line, a smaller figure even than last year. On the other hand electric lighting enterprise is still active. Out of 91 applications for provisional orders 70 relate to electric lighting, the proposed capital being more than £2,000,000; gas lighting orders being only 14 in number and requiring but £250,300 capital.

Technical Education.—In a recent letter I informed you that a special committee of the London County Council had recommended the granting of large sums of money annually to the promotion of technical education in London. At the last meeting of the Council the report of this committee came up for discussion, and after a lengthy and instructive debate an amendment hostile to the recommendation was carried by a majority of five, there being a strong feeling that instead of placing additional burdens upon the rate payers the large funds at the disposal of the ancient Guilds of the City of London should be entirely devoted to this purpose. Provincial County Councils have, however, generally decided to devote sums which, considering their resources, cannot be called other than munificent, to the furtherance of technical education.

Board of Trade Rules for the Protection of Telephones.—At the recent meeting of the electrical trades section of the London Chamber of Commerce, there was considerable discussion in connection with some clauses which the Board of Trade propose to insert in all future provisional orders granted to electric lighting companies. These clauses are somewhat long and are couched in the usual wordy phrascology common to government decrees. The pith of the matter, however, is extremely simple, namely, that electric lighting companies will in future have to exercise all manner of precautions in the construction of their mains and the working of their undertakings to prevent the disturbance of any telephonic line, either in existence or subsequently erected. This sudden solicitude for telephone wires is somewhat puzzling and it is thought in some quarters that it may be due to a desire to afford stringent legal protection to the telephones, in order that when the time again comes round, six years hence, for its purchase by the government it may then be adequately protected. It seems therefore probable that electric lighting companies in this country will meet with opposition similar to that which electric railway companies have encountered on your side. It is needless to say that the electric lighting companies are up in arms.

The Electric Light in the City of London.—The companies who have obtained the contracts for the lighting of the city, namely, the Brush Electrical Engineering Company and the Laing, Wharton and Down Construction Syndicate, being essentially manufacturing companies and with a limited capital, it was obvious from the first that they would have to transfer their contracts to a company formed specially for the purpose. Indeed, this was recognized by the city authorities themselves, and a clause was inserted in the parliamentary powers obtained by the contracting parties safeguarding the interests of the city in the event of a transfer. The chief point insisted upon in this clause is that the company to which the contracts may be transferred must not be one of the existing metropolitan electric lighting companies. This condition, of course, rendered necessary the formation of an entirely new company. On Monday the public subscription was invited in connection with the City of London (Pioneer) Electric Lighting Company, with a capital of £100,000 in 2,000 shares of £50 each. The chairman of the company is the Lord Mayor of London, and among the members of the board is the Duke of Marlborough. This company has been formed to *initiate* the supply of electricity in the city of London, with the ultimate intention of evolving itself into a larger company, which will do something more serious than merely *initiate* the scheme. Although the formation of some such company was, as we have pointed out, rendered necessary by the circumstances of the case, it is not altogether apparent to the non-business mind why it should be necessary to take *two* bites at the cherry.

LONDON, Feb. 18, 1891.

Electric Launches.—The four little electric launches which during the Edinburgh Exhibition last year conveyed close upon one hundred thousand persons along the canal between the city and the Exhibition are now about to be placed upon Lake Windermere, where they will ply for hire.

The Electrical Purification of Sewage.—The corporation of Salford, near Manchester, which instituted last year an exhaustive series of experiments with a view of ascertaining the most efficient method of purifying sewage, has just received the special report of the committee appointed to investigate the matter. Four systems were tested, namely, the "International," the "Electrical," the "Aluminoferru" and the "Barry." The two former have been reported favorably upon, and the report concludes as follows: "If the 'International' or the 'Electrical' company will guarantee the Corporation of Salford to produce an effluent from the whole of the Salford sewage which shall equal the effluent they have produced during the last few months, then the corporation will be justified in expending the large sum of money that would be entailed in purifying the sewage."

Electric Subway Railways in London.—On the second reading in the House of Commons on Thursday of the Central London and South Kensington & Paddington Railway bills, an interesting debate arose upon the question of inserting clauses in the bills requiring payment to the local authority of a royalty after a fair interest on the capital and working expenses had been paid, as compensation for the right granted to the companies to tunnel under the public streets. It was argued in opposition to this proposal that gas, water and similar companies were not taxed in this way, and that these concerns already paid large sums to the relief of the rates in the form of local taxes, and that furthermore the subsoil was not vested in the public authority, but in the house owners on either side. Omnibus companies, it was also pointed out, were absolutely exempt from taxation. Perhaps the most feasible and fair suggestion was, that the public should benefit from the success of any such lines, not by the relief of the rates, but by a reduction of fares, and that Parliament might well insert a provision that when the projects made profits to a certain extent, the fares should be reduced. One member went so far as to argue that the promoters of this scheme, far from being taxed, should be regarded by the local authorities as their best friends, inasmuch as by running these underground railways they diminish the wear and tear of the streets. Although no formal instructions were given to the committee, which is about to consider these bills in detail, it was generally understood that the propriety of inserting some clause by which the public would benefit by the success of these lines would be considered.

The Chelsea System of Distribution.—The paper which was read on Jan. 22 before the Institution of Electrical Engineers by Major Gen. Webber on the "Chelsea System of Electrical Distribution," although of a very lengthy character, was not exactly replete with interesting information, a fact which was commented on somewhat severely in the discussion, which took place on Thursday last. Perhaps the two chief points of interest mentioned by Major-Gen. Webber were, first, that the Chelsea Company's experience showed that they could produce one electrical horse power a the consumers' terminals for the consumption of 7 pounds of coal a the Central Station, and, secondly, that continuous current transformers had proved reliable, efficient and of great assistance. In the discussion Prof. Forbes stated that his impression that the system was almost too complicated to be worked had faded away upon an inspection of the actual apparatus in operation. In connection with the point raised by Major-Gen. Webber, that 8 c. p.

non-frosted lamps should be used, he was strongly of the opinion that better lighting would in most cases be obtained by employing lamps of large candle power with frosted bulbs. He stated that frosting did not necessarily mean perceptible absorption of light. Referring to the various systems of underground mains now in use in London and the provinces, Prof. Forbes described an effective method of localizing faults employed at Bath, a method which, as Mr. Mordey afterwards pointed out, had been used at Oporto by Mr. Henry Sayers and Mr. Spagnoletti. A trolley carrying iron plates, round which coils of wire connected to a telephone are wound, is taken along the roadway over the mains, through which an intermittent current is passed. When a fault is passed a most distinct change occurs in the sound emitted by the telephone. Mr. Crompton made a vigorous onslaught on the system adopted at Chelsea. He was and had long been an advocate of storage batteries, but only thought their use advisable as a means of supplementing the supply during the hours of heaviest load and of enabling the machinery to be stopped during the hours of lightest load. There was a limit to the use of storage batteries, and that limit had long been passed by the Chelsea Company, whose enormous number of cells and highly complicated apparatus was costly and liable to failure. He was disappointed at not finding a statement as to the actual cost of the system. The time had now arrived, he thought, when a comparison of statistics would benefit the whole industry. Mr. Frank King, who is mainly responsible for the design of the Chelsea system, referring to the important factor of cost, as influenced by the deterioration of the storage battery plates, said that the Chelsea Company had had in use 57,970 plates for an average period of 18 months, and it had only been found necessary to replace 30, and these had been required through mechanical accidents. In his reply Major-Gen. Webber said that he thought that he had given as many figures with regard to the cost as was fair, considering it was almost a new concern. Several speakers had remarked that not only were the bitumen cases employed by the Chelsea Company very friable, but that they were porous, and could not be considered as insulators. He could only say that they had withstood the ordinary vicissitudes to which all bodies laid under the London streets were subject, and were sufficiently insulating to be looked upon as an aid to the insulation of the conductors.

The Cost of Accumulator Traction.—Most of the figures which have hitherto been published with regard to the cost of accumulator traction have been of little commercial value. Sanguine advocates of accumulator cars have, after a few months of experimenting on a model or on an ordinary track, brought forward one set of figures; and others, after fitfully running one or two cars under exceptionally trying conditions, have brought forward another set. Naturally there was a considerable discrepancy between the figures obtained by such diverse processes, and comparison and analysis were rendered all the more difficult by the absence of information as to how the cost per car mile was arrived at, and what it included. Some figures which were made public last Monday by Mr. Kapp, in his first Cantor Lecture on "The Electric Transmission of Power," are, however, of a very different character. As many of your readers may recollect, the General Electric Power and Traction Company, after considerable preliminary experimenting, entered about a year ago into a contract with the North Metropolitan Tramways Company to run a regular service of accumulator cars on the Barking road section of its system at 4½d. per car mile, driver included. A generating station was erected and equipped at a cost of £3,500, and six cars were fitted up at a cost of about £450 apiece. During the first 12 months the five cars in regular operation ran 100,844 car miles, or within a few per cent. of the maximum possible, and the regularity of the service left nothing to be desired. The figures supplied to Mr. Kapp by Mr. Frazer, one of the contracting company's engineers, show, however, that the result of the first year's working has been a loss of nearly £1,500, the running expenses per mile having amounted to 8d. instead of 4½d. This result must, I think, be taken as definitely settling the question of accumulator traction. The Barking road line is fairly level, fairly straight and in fairly good repair. The accumulator cars were, in short, working under average conditions, yet the mere *haulage* expenses have amounted to within 2d. of the average *total* cost of tramway working in London, and have *exceeded* the cost of horse haulage by about the same amount The figures are set out in great detail, and although accumulator traction has not the same potential possibilities with you as with us, provided it can compete with horse traction, some of these items may be of interest. The cars weigh 3.275 tons, the motors and gear 1.36 tons, the batteries 2.4 tons, the passengers 3.6 tons; total rolling load of 10.63 tons, of which 34 per cent. is paying. The car miles run were, as I have mentioned before, 100,844, and the running expenses were £3,390. Wages at generating station amounted to £677; drivers' wages, £902; fuel, £434; oil, £64, the balance of £1,777 being made up of depreciation and repairs. By far the most formidable item under the latter heading was, of course, battery depreciation, though the figure will, I think, surprise even those who have taken a pessimistic view of accumulator traction. Battery depreciation and repairs amounted to £1,184, or 66 per cent. of the prime cost, and alone added 2.8d. to the cost per car mile. The motor repairs were the next most important item, costing £1,000, or .428d. per car mile, Although 50 per cent. depreciation was allowed for gearing, this only meant £72—.171d per car mile. Thus the item "depreciation and repairs" of the electrical plant on the car itself alone amounted to a total of nearly 3¼d. per car mile, a result which speaks for itself.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Electric Lighting by Gas Engines.—Can you inform me through THE ELECTRICAL WORLD of any electric light system for town lighting being successfully run by gas engines? H. M. T.

Yes; there is a very successful gas plant in Woonsocket, R. I. This plant was described in THE ELECTRICAL WORLD of July 12, 1890.

Storage Cell Charged from Primary Batteries.—Can I successfully use a primary battery to charge a storage cell? I have but one storage cell, with which I run a phonograph, and cannot conveniently charge the cell by dynamo without taking it six miles. R. L. McI.

Yes, you will have no trouble in charging your secondary battery from a primary battery. For this purpose I would advise you to use three or four large low-resistance bichromate cells connected in series; charge precisely as you would with a dynamo.

Long-Distance Power Transmission.—Is it possible for a current to be transmitted a distance of 15 miles for power purposes, and, if so, what per cent. of loss will there be? W. F.

The distance is easily practicable, and the loss in transmitting through that distance is only limited by the amount of copper one cares to put in the line. This, in turn, depends on the cost of power where it is generated, for where power can be obtained very cheaply it is cheaper to let a considerable percentage go to waste than to pay for copper to save it. Twenty per cent. loss on the line would not be excessive in most cases.

News of the Week.

THE TELEGRAPH.

The Pacific Cable Company.—The House Committee on Foreign Affairs has agreed, though not unanimously, to report to the House, with some modifications, the bill to incorporate the Pacific Cable Company. Representative Chipman will report the bill. The principal change made in the bill was to reduce from $200,000 to $150,000 the sum to be paid to the company annually for 15 years by the United States government after the cable is completed and open for business.

A Probable Cable Consolidation.—The probable result of the coming interview of Gustav Belleville, administrator of the Campagnie Française du Télégraphique de Paris à New York, with J. W. Mackay, the president of the Commercial Cable Company, will be the transfer of the French cable into the hands of the Commercial Company. The French company, ever since the Commercial started, has been a part of the latter, the general manager of the Commercial being at the same time traffic manager of the French. It is said that even the Christmas bonus was given by Mr. Mackay to the employés of the French company. Mr. Belleville is president of the company which has been formed for the purpose of laying the cable from Charlestown to Puerto Plata. The right of landing has already been obtained from the Federal government, and work will be started very soon.

The Hawaiian Cable.—The proposition to appropriate $3,000,000 for the construction and operation of a telegraphic cable to the Hawaiian Islands has been discussed by the Senate, and was adopted as an amendment to the consular and diplomatic appropriation bill. The amendment provides as follows: To enable the President to make engagement with any such citizen or corporation of the United States as shall appear to possess the means and facilities necessary to that end for telegraphic communication between the United States and the kingdom of Hawaii, which engagement shall contain provisions sufficient, in the judgment of the President, to secure to the government and citizens of the United States early and equal communication by telegraph with said kingdom on reasonable terms for a period of not less than fourteen years, a sum not exceeding $250,000 is appropriated for each year during which the engagement shall be in operation and during which such engagement shall be so in course of execution, not exceeding twenty years, and the sum total paid under this authority shall not exceed $3,000,000.

THE TELEPHONE.

The Central Union Telephone Company publishes the following circular of general notice: "The assistant general superintendent's office having been removed to Chicago, the jurisdiction of M. J. Carney, superintendent, has been extended, and he has been appointed superintendent of this company for Ohio. Mr. Wm. J. Maiden has been appointed assistant superintendent for Ohio. The Ohio office will be in Columbus, O.

THE ELECTRIC LIGHT.

Frankfort, Pa., invites bids until March 30 for an electric light plant.

Union Springs, Ala.—An electric light plant has been erected.

Seattle, Wash.—The Home Electric Company started its plant last week.

Uniontown, Ala.—It is estimated that the water works will cost about $25,000.

Depere, Wis., is agitating the question of erecting its own electric light plant.

Royersford, Pa.—The charter for the Royersford Light, Heat and Power Company has been applied for.

Easton, Pa.—B. F. Shafer will begin work this week in extending the electric light plant. He will plant 100 poles and put up 20 arc lights.

Naugatuck, Conn.—The power plant for the electric light station has arrived, and it is expected that the lights will be running at an early date.

The American Electric Supply Company, 226 Pearl street, Buffalo, N. Y., has just completed the construction of an electric light plant at Fredonia, N. Y.

Keyport, N. J.—A petition for a municipal electric light plant has been circulated throughout the town, obtaining several signers, which will be brought before the Board of Town Commissioners.

New Albany, Ind.—Thomas H. Fearey, Louisville agent of the Central Thomson-Houston Company, has sold the Gas Light and Coke Company, of New Albany, Ind., a 650-light alternating current dynamo.

Marine City, Mich.—The Common Council has let the contract for lighting the city by electricity. The plant will be furnished by the Heisler Electric Light Company, of Philadelphia, and will consist of 100 incandescent lights. The annual cost is to be $1,400.

The New Steamer "Havel," of the North German Lloyd Company, lately arrived in port, is lighted throughout by incandescent electric lights. There are four dynamos, each of a power sufficient to light 350 lamps of a brilliancy equal to 25 candles each.

Akron, O.—The Edison General Electric Light Company has just completed installing, through Mr. P. T. Dunn, two large isolated plants here, the B. F. Goodrich Rubber Company a 450-light dynamo, and the Thomas Philips Paper Mill a 100-light generator.

Ashville, Miss.—The Ashville Land and Improvement Company has recently contracted for a complete equipment of 50 arc lamps, dynamo, wiring, etc., of the Western Electric Company's manufacture. The plant is being installed under the direction of W. H. Schott.

The Edinburg (Ill.) Electric Light and Power Company has begun placing poles for the lights. About fifty lights have been procured for the street crossings. All the stores will be lit up by the new plant. A few of the heavy tax-payers are trying to stop this improvement.

The Columbia Iron and Steel Company, of Uniontown, Pa., is about to light the interior of its immense buildings with incandescent lamps ranging from 16 to 100 c. p. The company has had an arc machine of the Brush type, giving 25 lights of 2,000 c. p., in use to light the exterior of their works for several years.

New Rochelle, N. Y.—The Thomson-Houston Electric Company began last week to light the town with 500 incandescent and a large number of arc lights, the current for which is generated in Mt. Vernon, four miles away. Mr. Norman T. Wilcox was the electrical engineer in charge. His work has been very successful.

Athens, Ga., is to have a second electric light plant. Mr. R. L. Bloomfield contemplates erecting an additional plant for the purpose of lighting the streets. Some legal considerations have debarred him from installing this plant some time since, and with these in a great degree removed nothing will prevent his plans materializing shortly.

Lowell, Mass.—The new electric light plant here is one of the largest in New England, and it will soon be in active operation. Its location in Belvidere is only a short distance from the heart of the city. The new station is designed for 3,000 h. p., and already 1,250 h. p. is installed. It covers a total area of 211 feet in length, 93 feet in depth, or about 20,000 square feet.

Mr. Edward Cobb, electrical engineer for the Capital City and Thomson-Houston Electric Light companies at Des Moines, Ia., has been promoted to the position of superintendent of distribution and assistant to general manager of the Capital City Gas Light Company, Capital City Electric Light Company and Thomson-Houston Electric Light Company.

Columbus, O.—The award of municipal lighting was made last week to the Columbus Electric Light and Power Company, and the conditions are that the company shall furnish 800 or more electric lights of 2,000 c. p. each, with all poles, lamps, globes, wires, fixtures and labor for five years, to be lighted strictly on the "all dark hours" schedule, at $75 per post a year.

Fresno, Cal.—A contract has been made with the Edison Light Company of this city for the establishment here of a central electric light station, under the direction of Charles R. Lloyd. The new establishment will have a capacity of 100 arc and 3,000 incandescent lights. This will give Fresno one of the best lighting systems on the coast, and will materially improve the aspect of the city at night.

Navy Yard Plant Test.—The continuous week's test of the Concord's new Edison electric lighting plant began last Saturday and is now progressing. Lieut. Lucien Flynne and Ensigns Field and Oman are superintending the trial. Tests will be made for insulation, endurance of machines, governing qualities of the engines and the compounding of the dynamos. No results have as yet been announced.

Boston, Mass.—At the recent town meeting in Hyde Park the selectmen were instructed to try to make a three-years contract with the Hyde Park Electric Light Company to light the public streets for the same amount per annum that the company offered to do it for on a seven-years contract. The company has refused to make the contract, and the selectmen, as further instructed, have advertised for bids. The price offered was $7,000 per year for 105 arc lights to burn until 12:30 A. M.

Thomson-Houston Sales.—The Western isolated lighting department of the Thomson-Houston Electric Company reports the following recent sales: Calumet Distilling Company, New Chicago, Ill., 200-light incandescent plant (increase); Bradner, Smith & Co., Chicago, one 20-light arc plant (increase); Woodcock & Loring, Clifton House, Chicago, one 12-light arc plant; Liss & Rickeman, 75 North Clark street, Chicago, one 120-light incandescent plant; D. B. Fisk & Co., Wabash avenue and Washington street, Chicago, one 35-light arc plant and 250 light incandescent plant.

Pittsburgh, Pa.—Superintendent Bowers, of the Bureau of Public Light, has submitted his annual report to E. M. Bigelow, chief of the department of public works. During the year the bureau expended for salaries $1,241.66, but the city paid $7,552.87 to the Allegheny County Light Company, $130,099.95 to the East End Light Company, and to the Pittsburgh Electric Light Company $988.72, making the total expenditures for the lighting $139,883.20. The total expenditures by the bureau, including salaries and the cost of repairs and new lamps, amounted to $141,803.91. The report also shows that there are 920 arc lights in the city, 280 incandescent lights and 2,917 gasoline lamps.

The Wilkinsburg (Pa.) Electric Company, near Pittsburgh, which recently purchased from the East End Electric Light Company all of the latter's lights east of the city line, including the suburbs of Brushton, Wilkinsburg, Edgewood and Swissvale, is making preparations to place in its plant at Wilkinsburg the additional machinery required for the increased number of lights. The plant when erected was built with the idea in view of providing plenty of room for enlarging the lighting facilities, and therefore requires no additions. Until the Wilkinsburg company is ready to furnish the increased power the East End company will continue to supply the lights in the new districts.

Georgetown, Colo.—The City Council has passed an ordinance giving a twenty years' franchise to Ludolph Martin, of Denver, to erect an electric power and lighting plant and carry its wires through the streets of this city upon poles or under ground, as may be deemed expedient. A stock company is now forming which will be partially made up of some of our enterprising citizens. Forty-three 20 c. p. lamps will be placed on the lamp posts, which are now standing, and Silver Plume will probably have about ten. They will be lighted all night. A 200 h. p. plant will be erected at the place as above designated. This plant will also furnish power to the mines and any others who need it. The Gas Company has been unceremoniously sat down upon.

Messrs. Craig R. Arnold & Co. have received an order from the Harlan and Hollingsworth Company, of Wilmington, Del., to fit out the new steamer "Pocomoke" with one of the latest Arnold marine plants. The engine will be of the rotary type, and will run at 200 revolutions per minute and be capable of developing 16 h. p. on 40 pounds steam pressure. The total floor space occupied by the engine will be five feet long by two feet wide, and it will weigh, complete with bed plate, etc., about 800 pounds. The dynamo will be capable of delivering 13,750 watts at 1,000 revolutions, and will weigh about 1,200 pounds. The power will be transmitted from the engine to the dynamo by the Arnold patented friction system, which has proved successful in many installations. This dynamo will operate 134 lamps of 16 c.p. in conjunction with one of the well-known Arnold search lights of 10,000 c. p., and will maintain a constant voltage irrespective of the number of lamps running, or of changes in speed.

Hyde Park, Mass., a suburb of Boston, at a recent meeting of its citizens voted to ratify and accept the seven years' contract made between the electric light company and the Board of Selectmen. This matter had been brought to the attention of the citizens at a previous meeting and they voted to refer the matter back to the selectmen with instructions to advertise for bids. This the

selectmen did, and as a result the local electric light company was the lowest bidder on a three years' contract. The matter of long contracts between local lighting companies and towns and cities seems to be coming to the front. Mr. Thos. T. Robinson, the treasurer of the Hyde Park Electric Light Company and also treasurer of the Dedham Electric Company, we believe, takes the leading steps in the matter of long contracts in Massachusetts, he having received from the town of Dedham a ten years' contract and from the town of Hyde Park a seven years' contract. We are advised that the stock of both of these companies is held by local people, and that the long term of contracts gives the same great strength.

The Allegheny County Light Company, of Pittsburgh, has decided to consolidate its three electric lighting plants into one large central station, and with this end in view has purchased property on the Allegheny River at the corner of 12th and Etna streets. This property was formerly used for foundry purposes and the buildings upon it will necessarily have to be remodeled. At present the Allegheny County Company has three central stations: the chief one situated in Garrison alley, Pittsburgh, one in Allegheny, and one on the South Side, or Birmingham. These properties will be disposed of and the amount realized for their sale will go toward meeting the expense necessary to get the new arrangement into proper working order. At present the total capacity of the company in incandescent lighting is forty-five thousand 16 c. p. lamps. The new plant will have three times this capacity and will consequently be the largest incandescent electric lighting establishment in the United States. It will be possible to institute many economies under the new arrangement which have been impracticable heretofore, in the Garrison alley plant. For instance, the engines are upon one floor and the dynamos upon another, making it necessary to have two crews of men to look after the machinery, and city water, which is very expensive, is used in the boilers. At the new plant the expense connected with the water supply from the river close by will be very slight, and all the machinery, engines, dynamos, boilers and switchboards will be on one floor. The total taxes will be appreciably less than those paid at present, and altogether a saving of $30,000 or $40,000 a year is expected to be made. The remodeling of the recently purchased buildings will not be completed until fall, and the new plant will not be ready for operation before the first of 1892, as the work involved is of considerable magnitude.

THE ELECTRIC RAILWAY.

The Biddeford and Saco Street Railway is to be equipped by the Westinghouse Company.

College Point, N. Y.—A number of trial trips have been made by the cars of the electric street railroad, which were very satisfactory, and within a week or two it is intended to have the road in operation.

Electric Traction for Jamaica Road.—The Railroad Commissioners at Albany have granted the application of the Jamaica & Brooklyn (N. Y.) Railroad Company to change its motive power from horses to electricity. The road will run eight miles an hour in Jamaica and 10 outside.

The Augusta (Me.), Hallowell & Gardiner Electric Railway is seven miles in length and is operating six cars. Next year, however, double this number of cars will be in operation, and it is intended that the length of the road will be increased. This road is one of the most carefully equipped and best-paying electric street railways in the United States. The annual report of the company showed net earnings of 38 per cent. on $108,000, cost of construction and equipment of the road, during the time it operated from July 26 to Sept. 30. Mr. E. K. Day, formerly with the Thomson-Houston Electric Company, at Lynn, Mass., is the superintendent.

Baltimore, Md.—A Philadelphia syndicate has secured control of the International Telegraph District and Construction Company, one of the corporations that furnish the electric lights for Delaware. Mr. La Roche is the new general manager. He promises such improvements of the service as will make patrons entirely independent of the gas companies. The new owners have put $100,000 additional cash capital into the concern. It is intended to enlarge the present station in Pratt street, by covering the entire lot with buildings and filling them with the newest and best machinery. The new management in a short time will also begin an arc light service.

Richmond, Va.—Governor McKinney seems to be unnecessarily alarmed as to the possibility of the electric light wire that runs into the capitol building doing some damage to the building or its occupants. This question came up nearly a year ago and he was about to order the discontinuance of the electric lights when petitions caused him to investigate the matter further. He admitted that the convenience of the light was great, but he had allowed himself to be prejudiced against electricity as an illuminating agent because fires had occurred at an insane asylum and a boarding school, which were charged to electric light wires, but which charges it transpired were never conclusively proven. He said in a recent newspaper interview that if sufficient reason were again presented to justify his ordering the discontinuance of the lights, he would of course do it.

The Industrial Improvement Company, of Boston, is interested in the purchase of the Allentown (Pa.) passenger street railway. The terms of the sale and everything else pertaining to the purchase have been fixed and agreed upon, and as soon as Allentown city councils pass an ordinance, or amend the present ordinance, giving the Boston capitalists the privilege to establish an electric railway in the city, which will require the erection of poles and running of wires along the streets traversed by the tracks of the company, so soon will the sale of the road be consummated. The plan is to join the Allentown line with the electric line to be built over the Allentown and Bethlehem turnpike by the Bethlehem and Allentown company, for which all the privileges have already been secured, and with the new Bethlehem and South Bethlehem electric railway, thus connecting and uniting Allentown with the three Bethlehems and making travel to and from these towns rapid, pleasant and enjoyable.

Electrical Street Car Propulsion.—Mr. D. H. Bates, vice-president and general manager of the Accumulator Company, reports that a contract has been made for the equipment of the new G street branch of railroad, Washington, D. C., with six storage battery cars. This railway company was one of the first street car roads in the United States to adopt electricity as a means of propelling its cars, and the Thomson-Houston system of trolley wires was installed there several years ago. Congress, however, will not permit the railway company to erect any more trolley poles, particularly in the heart of the city, and this storage battery system has been adopted. The cars are being manufactured by the J. G. Brill Company, of Philadelphia, and will be lighted by electricity, equipped with the Edco system of motors and gearing, the gearing running in oil, with dust-tight covers for motors, and with a number of "23 M" type accumulators, designed to give an average speed of eight miles an hour and a maximum speed, when desired, of 15 miles an hour.

LEGAL NOTES.

Thomson-Houston vs. Edison Company.—The Thomson-Houston Electric Company brought suit in the United States Circuit Court yesterday against the Edison General Electric Company for an injunction to restrain them from using several valuable electrical devices, of which they claim to control the patents. These devices are the carbon commutator brushes patented by Charles J. Van Depoele, of Chicago, Ill., and the electrical collecting devices patented by George Forbes, of Westminster, England. These inventions, it is alleged, are capable of conjoint use on dynamo machines, and are so used by the defendants in the infringement apparatus. It is claimed that the defendants are deriving great profits from the sale of these devices, and the complainants ask that they may be required to make a disclosure of all such profits and pay them over to them.

Chadbourne, Hazelton & Co., the general agents for the United States for the Wenstrom Consolidated Dynamo and Motor Company, of Baltimore, have entered suit against that company in the sum of $200,000 for commissions due and breach of contract. The Wenstrom Consolidated Dynamo and Motor Company was reorganized over a year ago by a syndicate of wealthy Baltimore capitalists. The capital stock of the company was $1,000,000. This company made a contract with Chadbourne, Hazelton & Co., whose offices are at 420 Walnut street, Philadelphia, to act as its general agents for the United States, and agreed to fill all orders promptly. The company, however, has, it is alleged, only paid in a small amount of capital, and the entire amount has been expended in building the factory and purchasing real estate. Chadbourne, Hazelton & Co. claim that they have secured a large amount of business and a great many very important and valuable contracts, but, owing to the poor management of the Wenstrom company, they have been unable to supply any apparatus, and suit is, therefore, brought to recover a large amount of commissions due on sales that were made, and also for damages for breach of contract. In regard to this suit and the complications which have led to it Mr. A. H. Chadbourne says: "As is generally known, we accepted the general agency for the United States, and organized a selling department with about 15 sub-agencies throughout the United States in the principal cities and we started in to work under what we believed to be the most promising circumstances. Nearly a year has passed, and, on looking over our records, we find that only about five per cent. of our orders accepted by the Wenstrom company for dynamos and motors have been filled. Only a few days ago we announced the closing of an important railway contract some 14 miles of track and various heavy electric locomotives and car equipments, and also a contract in Athens, Ga., and orders for equipments on several other roads. All these contracts and orders were accepted by the Wenstrom company, but within the last few days it has become apparent that some of the most important at least they will be unable to fill, so that the railway contracts which include the overhead construction, amounting to about $225,000, will probably be equipped with some other system. Mr. Hazelton and myself feel that the time has come when we must take a stand. While we cannot undo the harm that has been done, yet we are more desirous of placing ourselves straight before the people with whom we have been dealing than anything else. It is unnecessary to say that we shall stick to the "electric" business, and while we have not the most remote idea as to what our future steps will be, yet we are sure of one thing—that if we ever undertake to represent any company or attempt to close any contracts for the delivery of any kind of apparatus, electrical or otherwise, we will assure ourselves that we can deliver it within a reasonable time."

EDUCATIONAL NOTES.

SCHOOL OF MINES, COLUMBIA COLLEGE,
NEW YORK, N. Y., March 2, 1891.

Dr. M. I. Pupin, instructor of mathematical physics in the department of electrical engineering, announces the following course of university lectures "On the Principle of Conservation of Energy and its Application in Physics and Chemistry:" I. Introduction. A. *On the Simplest Phenomena.* (1) Motion of a material particle. The simplest accidents (*vide* Rankine for the definition of the term "accidents") of a material particle, viz.: Mass, velocity, momentum, acceleration, weight, *vis viva*, work. The absolute or mass system, and its relation to the practical or weight system of physical measurements. (2) Motion of a connected system of material particles and rigid bodies whose condition is completely defined by masses, space co-ordinates and their differential coefficients with respect to time. (The chief aim of these considerations is to sketch briefly the historical development of mechanics during the interval between Newton's announcement of the "Three Laws of Motion" and the discovery of D'Alembert's principle.) D'Alembert's principle and its relation to the complete demonstration of the "Principle of Conservation of Vis Viva." Lagrange's introduction of generalized space co-ordinates into the theory of motion of material systems. Lagrange's, Hamilton's and Jacoby's "General Dynamical Principles." (A detailed discussion of these principles is given, because it is through these principles and the principle of conservation of energy that the application of dynamics to physics and chemistry is made possible.) On the monocyclic material systems of Helmholtz. II. On Complex Physical Phenomena. On material systems whose condition cannot be completely defined by mass, space co-ordinates and their differential co-efficients. On the general accidents or properties of matter and the possibility of their quantitative measurement. On "Energy," or the most complex accident of a material body. On the convertibility of energy and the possibility of a definiti on of energy based on the principle of its convertibility. B. *On the Principle of Conservation of Energy.* III. "Historical Development of the Principle of Conservation of Energy," especially its connection with the historical development of thermodynamics. (A short review of the labors of Carnot, Joule, Colding, Robert Meyer, Helmholtz, Rankine, Thomson, Clausius, Hirn, etc.) A detailed review of Helmholtz's essay: "On the Conservation of Energy." IV. "Formulation of the Principle and a Review of the Lines of Argument Which Prove it." V. "On the Various Forms of Energy," viz.: Mechanical, thermal, electrostatic, magnetic, electromagnetic, chemical and luminous energy. C. *On the Application of the Principle of Conservation of Energy.* VI. On complex states of matter and their complete definition by means of the principle of conservation of energy. On the extended meaning of "kinetic" and "potential" energy, or the kinetic and potential energy of a complex state of matter. Validity of the dynamical principle of Lagrange, Hamilton and Jacobi in the case of complex states of matter. VII. Application of the extended dynamical principles to the study of physics and chemistry. A brief review of the investigations of Rankine, Maxwell, Helmholtz and J. J. Thomson. The course commenced about the middle of February. There will be one lecture of two to two and a half hours per week. The course is one of the university courses in the Department of Mechanics; the lectures will, therefore, be delivered in Prof. W. G. Peck's lecture room. Day and hour will be fixed to suit the convenience of the majority of those interested in these lectures. The course will extend over three terms.

PERSONALS.

Mr. C. A. Smith, of the New Haven Copper Company, leaves on March 8 for Nicaragua to superintend the construction of electric lights along the Panama canal.

Mr. Myron D. Law, well known as a prominent member of the National Electric Light Association, and who has for some time been located at Denver, Colo., has been appointed manager of the arc light department of the Edison General Electric Company.

Mr. Albert M. Johnson, known for several years in the sphere of telegraphy, and lately of the Mobile (Ala.) Telephone Company, has accepted the position of professor of telegraphy and railroading in the Teddin Actual Business College at Memphis, Tenn.

Mr. William D. Palen, late of the Edison General Electric Company, has taken a position as electrician with the Crocker-Wheeler Motor Company, of New York, to have charge of the testing and inspection of the perfected apparatus at the factory of the latter company.

Industrial and Trade Notes.

The Thomas Murray Company, of New York City, is to begin track work on the Buffalo Street Railway this week.

The Stewart Heater Company, of Buffalo, N. Y., has just sold to the Thomson-Houston Electric Company one heater of 1,000 h. p. for use in the Buffalo Electric Light and Power Company's station.

The Jerome Kidder Manufacturing Company has added to its extensive line of goods a standard milliampère meter calibrated from the C. G. S. standard instrument, by Prof. Edelmann, of Munich, Bavaria.

The Illinois Electric Material Company, of the Rookery Building, Chicago, dealers in electric light, street railway and general electrical supplies, has issued for 1891 a new catalogue of its general supplies and specialties.

The Page Belting Company, of 16 Dey street, New York City, has issued a circular announcing its opening and exhibition. This company is the manufacturer of the "Acme" leather link belt and the "Eureka" dynamo belt.

The Electrical Supply Company, of Chicago, has a new crossing cleat that is attracting favorable comment from the fact that it is no larger than the ordinary cleat, yet provides a perfectly safe and easy means of crossing circuits.

The Electrical Supply Company has recently carried out a careful test of the Ajax dry battery cell. After working without any interruption for one hundred days, the E. M. F., it is claimed, stood above five other well-known cells which had been on the same tests.

Mr. Willard H. Platt, of Greene, Tweed & Co., New York, in referring to the North Carolina mica handled by his well-known firm, speaks of the excellent qualities of toughness and flexibility, and the ease with which it can be split into as thin sheets as may be desired.

The Detroit Electrical Works has issued a handsome catalogue of the "Rae" electric railway system, which, with numerous excellent cuts and exhaustive descriptions of the "Rae" fittings, makes a pamphlet wherein can be found full information pertaining to electric street railway equipment.

Messrs. Benjamin F. Kelley & Son, of 91 Liberty street, New York City, are meeting with great success in the introduction among electric light stations of their "Maypole Improved" exhaust pipe head. With this apparatus it is claimed there is no noise nor back pressure, and that it prevents the usual water and spray which accompanies an open exhaust.

The Baxter Electric Motor Company, of Baltimore, Md., has issued a small book giving many clear views of this company's railway equipments, with an explicit description of its traction system. The motor used by this company, which was illustrated in THE ELECTRICAL WORLD of Jan. 3, 1891, is of the multipolar slow speed type, using single reduction gearing.

Charles W. Wall, M. E., has issued a circular showing a copy of the letters patent granted to him for his improved belt gearing. The object of the invention is to provide an improved belt gearing whereby one or more machines may be safely thrown out of gear while they are running without affecting the other machines, and also to economize floor space.

The Electric Merchandise Company, of 11 Adams street, Chicago, Ill., has issued a most complete catalogue of its electric railway supplies and general station fittings. This company has the sole agency of a number of important street railway fittings, among which may be mentioned the Brewster trolley clamp, for which is claimed lightness and simplicity of construction.

Messrs. Joseph Ketchem & Co., manufacturers of cold process lead cable casing and insulating material, have placed upon the market a new insulating tape which will be known under their trade-mark of "D. D.," which distinctive name has long identified their insulating compound. The new tape is extremely adhesive and is waterproof, besides possessing high insulating qualities.

The Cambridge Accumulator is the latest candidate in the line of storage battery cells. One half the weight for the same service is claimed to be the main advantage of this cell over accumulators of other makes, and the method of containing the active material in the Cambridge cell is simple and efficient. The Cambridge Accumulator Company, of 60 Devonshire street, Boston, Mass., is the manufacturer.

Mr. Norman Hubbard, sole manufacturer of the improved "Niagara" steam pump, engines, boilers and general machinery, has been doing considerable business in the electrical sphere with the "Niagara" pump, having recently made sales to the following parties: U. S. Navy Department, for testing purposes in the Brooklyn Navy Yard; The Edison Electric Light Company, of Milan, Italy, and The Edison-Swan Company, of London.

The Campbell & Zell Company, of Baltimore, Md., has recently issued a complete catalogue of the "Zell Improved Water Tube Boilers." This company has been doing considerable business lately in electric light circles, among which sales the following may be mentioned: A 250 h. p. plant to the Hampton, Old Point & Newport News Electric Railway Company, of Hampton, Va., and a 600 h. p. plant to the Metropolitan Railroad Company, at Washington, D. C.

The A. W. Harris Oil Company, of Providence, R. I., manufactures a general line of lubricants adapted for electric light and power plants. That this company is keeping abreast with the progress in this field is demonstrated by its increasing trade, particu-

larly among electric lighting plants The works and eastern office are at 110 and 112 South Water street, Providence R. I. This Harris company, in order to supply the trade in the West, has recently opened an office and depot of supply at Chicago, and established an agency in Milwaukee with the Edward P. Allis Company.

The Tropical American Telephone Company is receiving letters from numbers of its old customers to whom samples of the new Tropical American Telephone Company's export sets have been sent for trial, all stating that they are much pleased with the new telephone sets, and not only commending the reduced price, but also the new transmitter, in which some important improvements have been made. The testimony is universal that they give perfect satisfaction. Orders are being received from Japan, India, Australia and Africa, as well as increased demand from old territory in Central and South America, Mexico and West Indies.

A High Grade Incandescent Lamp.—The New York and Ohio Company of Warren, O., is now in the market fully prepared to fill orders for its "High Grade" incandescent lamp that is the result of six years' practical experience and which has given the highest satisfaction after careful tests covering extended periods in the hands of competent electricians. Mr. J. W. Packard, the vice-president and general superintendent of the company, is the inventor of the well known Packard vacuum pump used in the manufacture of incandescent lamps of various types. Mr. W. D. Parkard, the secretary of the company, is well known in the electrical fraternity and was one of the prominent Western men at the Providence meeting. The Eastern agency is in the hands of Mr. J. W. Peale, the president of the company, who is located at No. 1 Broadway, N. Y.

The Engineering Equipment Company, organized early in February, has located temporarily at 73 Cortlandt street, New York City, and will after April 1st remove to the new Central Building, Liberty, West and Washington streets. The following gentlemen, and others, are actively interested in this new enterprise: F. A. Magee, M. E., engineer; F. L. Perine, general manager, and A. L. Tinker, secretary and treasurer. The company contracts for steam and electric equipment materials. The company represents the Underwood Manufacturing Company, of Tolland, Conn., makers of cotton-leather belts and other specialties in the belting line, and is also sole agent for the patent indurated fibre piping used in electrical subway work and for other purposes. The Engineering Equipment Company also represents the manufacturers of Corliss and high speed engines, horizontal and vertical boilers, wooden and iron poles, line materials, wire and cables, underground conduits, cars and trucks, iron roofs cranes, etc., etc.

Business Notice.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED FEB. 24, 1891.

446,846. Thermostat; Adolph M. Barron, of Kansas City, Mo. Application filed Sept. 19, 1890. A thermostatic circuit controlling device comprising an insulating-block having a recessed under surface, a disc sensitive to variations of temperature contained in the said recess, two binding-screws on the said base, a cross bar below the said disc, having a contact point thereon normally in contact with the said disc and connected with one of the said binding posts, and a metallic casting in the said block, having a contact point projecting from its base within the said recess and connected with the said disc, being connected with the opposite binding post.

446,864. Electric Motor; Ludwig Gutmann, of Pittsburgh, Pa. Application filed Sept. 18, 1890. The invention consists in using alternating or intermittent currents in the field-magnet coils of the motor, whose several cores are suitably subdivided to prevent heating, energizing the same, creating a magnetic field which, by induction, acts on one or more close-circuited ring-windings of the open or closed type, and generating in a single winding of the armature secondary currents differing in quantity and lag from one another by the external application of one or more short circuiting brushes. (See illustration.)

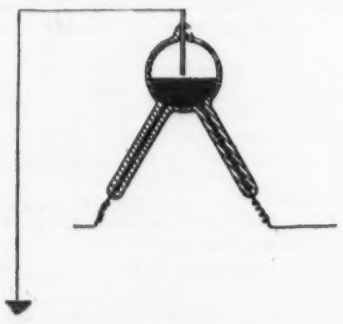
446,895. Fuse-Block; Albert P. Seymour, of Syracuse, N. Y. Application filed July 26, 1889. In a clamp or connecting device for electric conductors, the combination, with a screw and nut therefor, of two perforated clamp-blocks or pieces of metal between the head of the screw and nut, and a spiral spring encircling the stem of the screw.

446,902. Automatic Cut-Out; Jacob P. Tirrell, of Boston, Mass., Assignor to Horace A. Pinkham, of Philadelphia, Pa. Application filed June 4, 1888. This invention consists in an electric circuit having one or more independent branch circuits, each provided with gas lighting devices or other means for making and breaking the circuit, and an electromagnet having connected with its armature a movable switch or circuit-breaker adapted to cut out said branch circuit, an electromagnet included in the main circuit, a clockwork mechanism adapted to be set in motion and controlled by the armature of said electromagnet and a device adapted to be brought into action by said clockwork mechanism after the latter has been allowed to run continuously for a predetermined length of time by the prolonged closure of the circuit for moving the switch or circuit-breaker of any one of the branch circuit electromagnets the armature of which has been attracted by the closure of the circuit, whereby said branch circuit is cut out.

446,917. Electric Railway Signal; Earl T. Harvey, of Chicago, Ill. Application filed Nov. 6, 1888. In an electric signal for railways wherein the road is divided into independent electric signal sections, the combination, with the track rails at one end of a section, of the battery wires connected to the broken and insulated ends of said rails, the circuit wires connected to the rails at the opposite end of the section and returning to the battery end, and the contact signal plates located at each end of a section and electrically connected with reference to each other.

446,931. Trolley for Electric Railways; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 12, 1890. A trolley or traveler provided with a contact roller with a cylindrical periphery, and ears or guards projecting alongside said roller, beyond its periphery.

446,966. Cut-Out; Stephen Dudley Field, of Stockbridge, Mass., Assignor of one-half to Phœbus H. Alexander, of New York. Application filed May 28, 1890. A potential cut-out for



No. 446,966.—Cut-Out.

electric circuits, consisting of an inclosed fluid conductor, such as mercury, connected to the circuit, a grounded terminal adjacent to such conductor, and an interposed gaseous body of relatively higher conductivity than air. (See illustration.)

446,967. Electric Time-Lock; Malon I. Flowers, of Springfield, Mo., Assignor of two-thirds to James E. Jones and C. W. Price, both of Oklahoma City, Oklahoma Territory. Application filed May 5, 1890. In combination with a check-bolt, a dog for engaging said bolt, a time-wheel or dial for actuating the dog, means for rotating the wheel or dial, and connections for throwing the wheel out of engagement with its actuating mechanism.

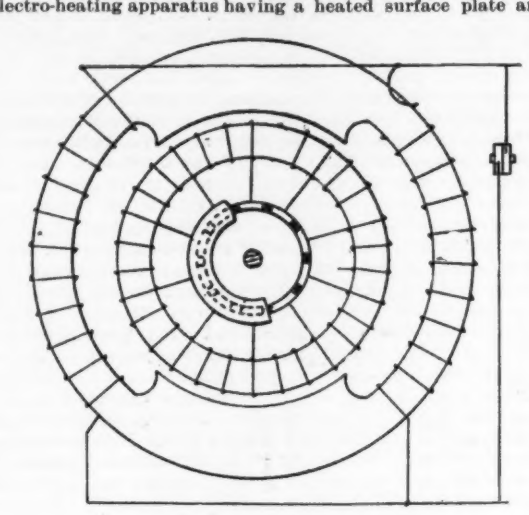
446,974. Method of and Apparatus for Electric Welding; Hermann Lemp and Louis M. Schmidt, of Lynn, Mass., Assignors to the Thomson Electric Welding Company, of Maine. Application filed July 23, 1890. The method of forming longitudinal metal joints by a soldering, cementing, or welding operation, consisting in feeding the pieces to be joined through suitable pressure or other devices, while properly arranged so as to be pressed together by said devices, and passing a heating electric current through the material in a longitudinal direction before it reaches the pressure or other welding devices.

446,985. Trolley-Wire Hanger; Charles H. Macloskie and William E. Baker, of Boston, Mass. Application filed Nov. 18, 1890. In a trolley-wire hanger, a conical case having one or more arms, and a conical insulating block secured within said conical case.

446,995. Socket for Incandescent Electric Lamps; John M. Orford, of Bridgeport, Conn. Application filed Nov. 18, 1890. An electric lamp, having a suitable base, two pillars, one having an angular face, a key-shaft journaled between said pillars and having rotative and longitudinal movement in its bearings, a notched block adapted to engage the angular face of the pillar, a spring for determining such engagement, and a spring terminal with which said block may engage.

447,016. Galvanic Battery; Martin W. Robinson, Medford, Mass., Assignor to the Vulcan Electric Co., of Kittery, Me. Application filed June 6, 1890. A bath of one element of a battery, containing a chromate, bichromate, or chromic acid, in combination with a bath for the opposite element, consisting of sulphate of copper.

447,023. Electro-Heating Apparatus; Charles E. Carpenter, of Minneapolis, Minn. Application filed Sept. 27, 1890. An electro-heating apparatus having a heated surface plate and a



No. 446,864.—Electric Motor.

resistance, of a coating of enamel or its equivalent securing the resistance to but insulating it from said plate.

447,045. Magneto-Electric Signal Device; Noel B. Ginochie, of New York, Assignor of one-half to Elias M. Greene, of same place. Application filed May 9, 1890. A magneto-signal device having a generator and driving shaft therefor, and a series of circuit controllers connected to said driving shaft and a stop device for said driving shaft controlled by the circuit controllers.

447,058. Police Signaling Apparatus; Bernice J. Noyes, of Boston, Mass. Application filed July 28, 1887. The combination of the following instrumentalities, viz., a main electric circuit, a signal transmitter for said circuit constructed and arranged to transmit, in conjunction with the signal, a differentiating impulse, as an impulse of long duration, a receiving instrument controlled by the main circuit, and indicating signal, a switch controlled by the differentiating impulse for governing the operation of said indicating signal, and another receiving instrument controlled by the main circuit, but rendered operative by the aforesaid switch.

447,059. Police Signaling Apparatus; Bernice J. Noyes, of Boston, Mass. Application filed July 28, 1887. In a signal-box, one or more rotating circuit-changing devices, combined with a number of detachable plates, each carrying characteristic contact devices and constituting circuit-controlling devices which co-operate with the circuit-changing devices to effect the transmission of a variable signal.

447,061. Municipal Signal Apparatus; Bernice J. Noyes, of Boston, Mass. Application filed Sept. 14, 1888. In accordance with this invention an audible alarm or indicating signal is provided at the main or central station, which is responsive to some of the signals transmitted, and to effect this result an induction coil is placed at the sub-station, the primary coil of which is included in a local circuit containing a battery and circuit wheel and pen, while the secondary cell is included in the main electric circuit.

447,062. Signal Box; Bernice J. Noyes, of Boston, Mass. Application filed Sept. 11, 1889. In a signal box containing a signal transmitter adapted to be operated by a key inserted through a keyhole, the combination, with the key formed to print, impress, or emboss a character indicating a number or equivalent by which the key is known, of a piece of material upon which the said character is printed or embossed.

447,074. Non-Interference Fire-Alarm Signal-Box; William H Kernan, of Brooklyn, N. Y., Assignor to the Gamewell Fire-Alarm Telegraph Company, of New York. Application filed March 1, 1889. An electric signal transmitter, having circuit making and breaking signaling mechanism, a motor for operating such mechanism, and a magnet in the signaling-circuit, a handle for starting the motor; a mechanical disabling device for the starting handle, an armature for said magnet, carrying and directly moving the disabling device, and a resetting device operated by the motor and moved thereby at the conclusion of a signal

447,104. Electric Welding Apparatus; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed Nov. 1, 1890. In an electric welding apparatus, the combination of a clamp adapted to compress the work laterally and having one jaw insulated from the other, terminals of an electric circuit connected to said jaws, grooves in the inner faces of said jaws transverse to the line of movement of the movable jaw, and suitable means to apply lateral pressure to the work with said clamp.

447,105. Independent Electric Clock; Walter J. Dudley, of Everett, Mass. Application filed Oct. 18, 1890. The combination of the time-measuring vibrator with the impelling lever and its restoring electromagnet and armature, a detent for supporting said impelling lever after being raised and released by said magnet, and the second lever pivoted independently of said impelling lever and co-operating with said detent.

447,127. Vacuum Core for Electrical Heating Devices; Henry R. Butterfield, of Waterville, Me. Application filed June 25, 1890. In an electric heater, a hollow core inclosing a vacuum and a resistance which forms part of an electric circuit, the said core being provided at one end with a partition cutting off a space, a screw-plug closing at will air outlets in the said partition and the end wall of said core, or the latter only, a water outlet cock from said space, and a steam inlet into the body of the core.

447,143. Electric Heater; John I. Ashbaugh, of Chattanooga, Tenn., Assignor of one-half to David G. Curtis, of same place. Application filed March 15, 1890 In an electric heating device, a solid central bar or part of clay or its equivalent, a coil of wire closely wrapped about this solid centre, through which coil passes the electric current, and a heat-conductor envelope surrounding the said coil, said envelope preventing the conduction of electricity.

447,166. Telegraph Transmitter; Samuel Wesley Smith, of New York. Application filed Nov. 13, 1890. A telegraph transmitter comprising a revoluble shaft carrying sending mechanism and having a pinion fixed thereto, a slotted tube arranged opposite the pinion, a spring-pressed shaft mounted in the tube and having one side formed into a rack to engage the pinion, and means for closing the circuit through the shaft pinion and sending mechanism during the upward movement of the shaft.

447,177. Regulator for Electric Circuits; Thomas M. Edwards, of New London, Conn., Assignor to Thomas M. Williams of same place. Application filed Nov. 5, 1890. An electric regulator, having a liquid-resistance receptacle, a pivoted lever, having a locking screw handle and contact end, and a contact plate immersed in the liquid, said lever being adapted to be moved upon or away from the contact plate in the liquid or out of the liquid.

447,194. Telephone; Ernest Jules Pierre Mercadier, of Paris, France. Application filed May 26, 1890. In a telephone, a diaphragm tuned to respond to one rate of vibration only.

447,195. Annunciator and Indicator System; John E. A. Miller, of San Francisco, Cal. Application filed Sept. 5, 1890. In an electric signaling system having a magnet, having its armature provided with a bearing of the switch member, movable longitudinally, a second switch member having a point arranged to engage in the bearing, and arranged when released from the bearing to engage the first switch member, an annunciator bell, indicator and battery, and the necessary connecting wires.

447,198. Telegraph Apparatus; Josiah A. Parker, of St. Louis, Mo. Application filed Feb. 28, 1890. An electric telegraph having a number of divaricate circuit closing or breaking keys, each key having at the ends finger-buttons for the corresponding fingers of the right and left hands.

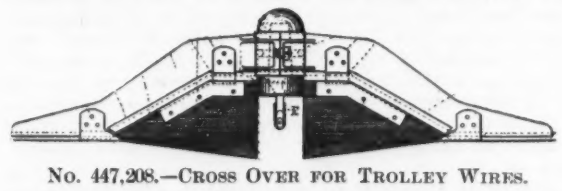
447,208. Cross-Over for Trolley Lines; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Co., of same place. Application filed Oct. 22, 1890. In accordance with this invention the cross-over is composed of an arch, preferably of metal, provided with clips which inclose the conductor in arched position—that is to say, with a curve at the cross-over upward above its normal level—and with one or more track pieces, preferably of insulating material, on which the trolley runs in making the crossing. (See illustration.)

447,215. Electric Railway System; Charles J. Van Depoele, of Lynn, Mass. Application filed March 7, 1889. A system of supplying and distributing currents for electric railways, comprising working conductors along the line of way, a circuit supplying currents of relatively high potential, main tension-reducing devices connected with the high-tension circuit and continuously supplying currents of lower potential to the working conductors, and auxiliary tension-reducing devices distributed along the line of way and provided with automatic means for closing the circuits and rendering the auxiliary converters operative upon the fall of potential in the working circuit.

447,220. Transmitter Circuit; Anthony C. White, of Boston, Mass., Assignor to the American Bell Telephone Company, of same place. Application filed July 24, 1890. A telephone system having a plurality of independent metallic circuits, a transmitter and a receiver in each circuit, and a transmitter-energizing battery common to all said circuits, the circuits being adapted for connection at one end to one pole of said battery and at the other to one end of any of the other circuits of the system, so as to form therewith a continuous circuit through the instrument of both circuits and through said battery.

447,230. Current-Controlling Device for Electric Railway Cars; Jacob C. Chamberlain, of New York. Application filed Sept. 9, 1889. This invention consists of an electric circuit, groups of batteries, a motor, and a regulator having a series of contacts for changing the grouping of said batteries and co-operating therewith, separate series of contacts adapted to connect said batteries with opposite poles of said motor, all of said contacts being mechanically connected so as to move together.

447,255. Electric Motor Mechanism; Samuel E. Mower, of New Haven, Conn., Assignor to Henry G. Thompson & Sons, of same place. Application filed May 31, 1890. This invention consists in an axle, a continuously running electric motor, speed-re-



No. 447,208.—Cross Over for Trolley Wires.

ducing gears connecting the revolving armature shaft of the motor with the axle, one of the said gears being loose on the axle, a second set of speed reducing gears connecting the armature shaft with the axle, one gear of the second set of gears being loose on the axle, and a double beveled cone friction clutch mechanism secured on the axle intermediate of the loose gears of the speed-reducing gears.

447,256. Apparatus for Flashing and Exhausting Incandescent Electric Lamps; William E. Nickerson, of Cambridge, and Adolph Berrenberg, of Somerville, Mass., Assignors to the Beacon Vacuum Pump and Electrical Company, of Portland, Me. Application filed June 20, 1890. This invention involves one or more electric lamps connected to an exhaust apparatus, a main circuit for flashing the filaments of said lamps, a local circuit including a circuit-closing device operative upon admission of air to the exhaust apparatus, and a cut-out for the main circuit controlled by said local circuit.

447,279. Secondary Battery; Stanley Charles Cuthbert Currie, of Philadelphia, Pa., Assignor to the United Gas Improvement Company, of same place. Application filed Nov. 18, 1890. The invention consists of a battery element comprising an interior support provided with a shoulder, an exterior woven tube fitting onto said shoulder, and extending beyond said support, and a porous metallic substance or materials cast within said tube and around said support.

447,283. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Electric Co., of Connecticut. Application filed Dec. 6, 1890. An electric railway, comprising the track rails having a curved portion and a suspended working-conductor arranged at an elevation above the rails and extending along said railway and about its curve, in which the curved portion of the working conductor is arranged farther from the centre of curvature of the railway track than would be the case if the conductor were extended around the curve with the same relative position to the rails occupied by it on the straight portion of the railway.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.